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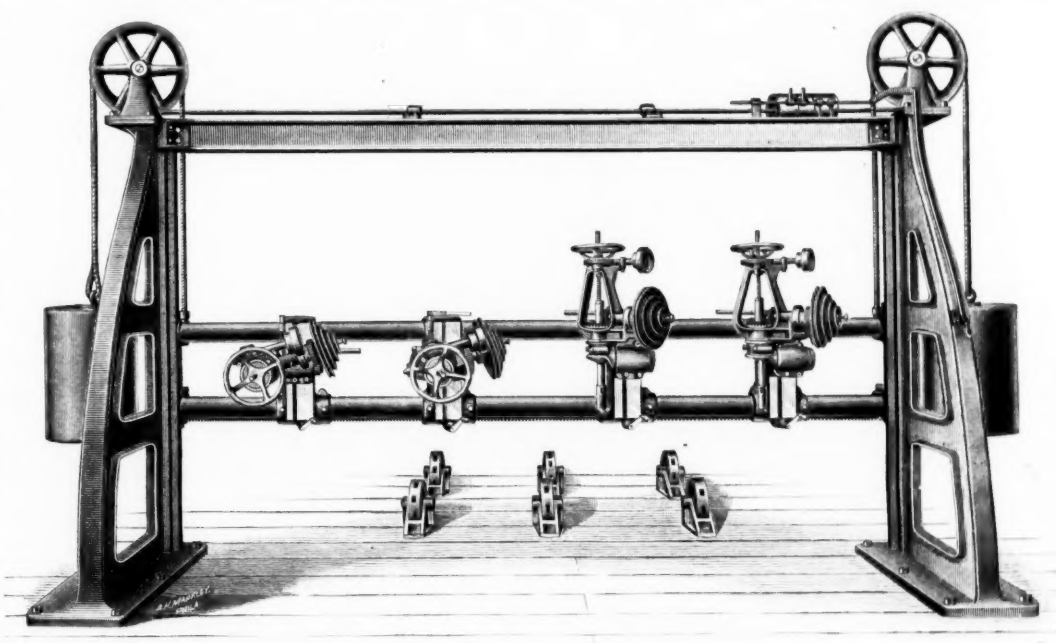
Boiler Shell Drilling Machine.

On this page we give an illustration of a machine designed and built by Thomas H. Dallett & Co., of Philadelphia, especially for the purpose of drilling the holes in boiler shells after they are bent and bolted together. It is also suited for doing other work on boilers, such as drilling stay-bolt holes, cutting flue holes, etc. By its use in the machine shop, holes may be drilled in large castings such as are used in heavy engine or other work, and the machine will be found to be very efficient for such service, since any number of heads desired, from one to four, may be used simultaneously, and the machine has ample power and strength to drive them to their full capacity.

The heads are fitted to move horizontally on two heavy steel bars, on the lower one of which is the rack by which this movement is effected. They each have also a limited vertical movement, by which the drill may be exactly adjusted to a given point after the shell has been turned nearly to the proper position, this movement being independent of the movement of the cross-rail upon the uprights, which is effected by vertical screws connected at the top by a horizontal shaft and bevel gears, the latter being driven by power by means of the tight and loose pulleys, as shown. The drilling heads can be turned to any desired angle by means of a worm and tangent wheel, and things are so arranged that the operator, standing on either side of the machine, has full control of the horizontal and vertical movements of the heads.

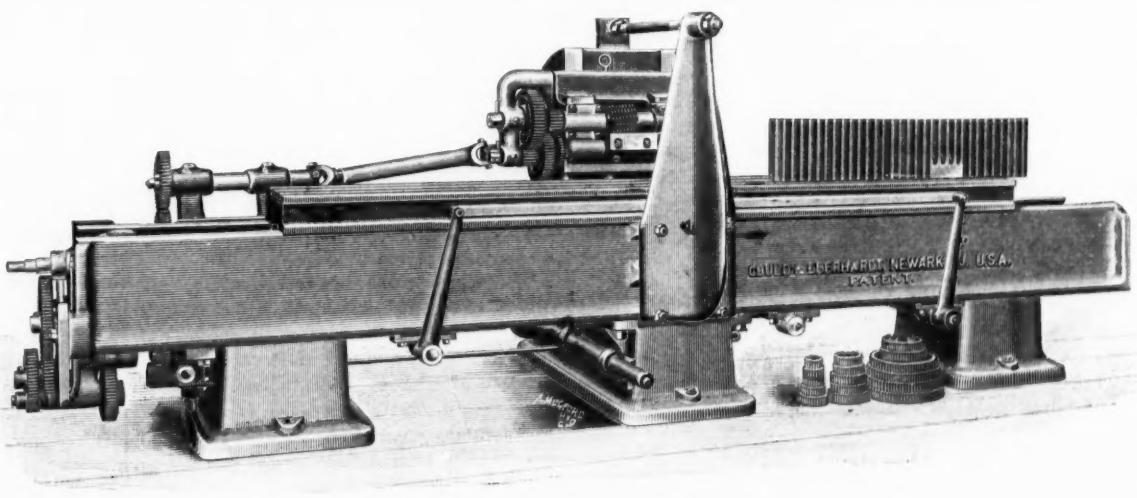
The boiler shell rests horizontally upon four or six rollers in front of the machine, so that it can be revolved to bring any part within range of the heads. The roller frames have bolt holes at each end, so that they may be fitted to sills or plates in front of the machine, and their position easily changed to suit different sized shells. The machine can be built with from one to four heads, as required. The horizontal range is 12 feet from center to center of spindles when heads are farthest apart; vertical range of crosshead, 7 feet; vertical adjustment of drilling head between beams of crosshead, 12 inches; the spindles have 13 inches traverse, and automatic feed; total height of machine, 11 feet; length over all, 18 feet.



BOILER SHELL DRILLING MACHINE.

Improved Automatic Gear and Rack Cutting Machines.

As most of our readers know, the firm of Gould & Eberhardt, of Newark, N. J., have for years past given much attention to the development of automatic machinery for the production of cut gearing, and we have from time to time published illustrations of some of this machinery. We present herewith engravings of two machines, which represent their latest practice in this line, the one on this page being their latest as well as the largest machine yet built for automatically cutting the teeth of racks. The machine has capacity for cutting a rack up to ten inches face and to ten feet long at one setting, and up to three-inch actual or linear pitch, using one to twelve cutters, according to the pitch being cut. Of course it is also practicable to cut simultaneously any number of racks of the same pitch whose combined width does not exceed ten inches.



AUTOMATIC RACK CUTTING MACHINE.

The machine may be said to consist essentially of a heavy bed, supported upon three pedestals, and having gibbed to its top a platen to which the work, or a vise for holding the work, is secured by means of T slots. This platen is moved by means of a large screw, which passes from end to end of the bed, being driven by the gears which compose the spacing mechanism seen at the left. The spacing is done in much the same manner as on the gear cutting machines, viz., by a friction wheel, which a running pulley always tends to revolve, but which is allowed to revolve only at such times as the platen is to be moved for a space, a stop being then automatically removed, which allows the friction wheel to make just one revolution, when its motion is again arrested until a cut has been made and the cutter withdrawn; then another movement takes place, and so on to the completion of the job. Suitable gears are placed between the friction wheel and the screw, so that the single revolution of the former gives the proper amount of motion to the latter, whether it be only a fraction of a turn or several complete turns. The spacing may be changed from the diametral to the linear system by means of two change gears provided for the purpose, these gears being always in place ready for use.

The central pedestal, upon which the bed of the machine stands, is extended out at one side, and upon this extension is a substantial upright, upon the face of which is the saddle that carries the cutter arbor. This is gibbed to the upright, upon broad, sliding surfaces, and is given a vertical movement by means of a heavy screw, which passes up through the upright, and is given an accelerated motion for the quick return of the cutter.

The spindle is driven by means of gearing, motion being transmitted from the driving belt to the gears by means of a shaft having telescopic slides and universal joints, this shaft and the joints being so proportioned and run at such a speed as to give ample strength and power. No cone pulley is used, but the speed can be varied when desired by changing one gear, this having been shown by experience to be a more satisfactory arrangement for such a machine than a cone pulley, the speed, of course, being required to be changed much less frequently than is the case with other tools, such as the lathe or drill press.

A tie rod extends across the top of the machine from the upright to a standard on the other side, which greatly increases the rigidity, and the machine is a very powerful one, doing the heaviest work very steadily and smoothly, as we can testify from seeing it in operation while being tested previous to shipment.

The platen moves in either direction when in operation, so that it is not necessary to move it back at the completion of a rack, but another one can be put in and the platen instantly arranged to move in the other direction, thus not only economizing time, but distributing the wear much better than if the spacing motion was in one direction only. Where racks of the ordinary shape are being cut, a vise (not shown) is used, this being much the same as those used upon planers, except that it is made in a form similar to that of an angle plate, so that the work is held vertically. Any desired arrangement of cutters may be made where more than one is used; as, for instance, where two are to be used both may be finishing cutters, in which case the machine is made to move two spaces for each cut, and, of course, two teeth are finished at each cut. Or, one cutter may be for roughing while the other finishes, in which case the platen moves only one space. Or, supposing twelve cutters to be in use, all of them may be finishing cutters if the size of tooth and nature of the work permit it, so that twelve teeth are finished at one cut, or any proportion of them may be for roughing.

When using a gang of cutters, the cutting points are so set as to form a spiral line as shown in the engraving, which has been found to make the work much easier, and more free from vibration. The engraving shows a heavy rack, which has been cut on the machine, finishing four teeth at each cut, as shown by the uncompleted cut. A complete system is provided for removing chips and oil, if oil is used; and there is a pump which

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A daily paper runs in the line, in every spare space, "Labor and Capital are One." The question that is not answered is, which is the one?

Trade societies are moving in England in the direction of getting more complete information as to the extent apprentices are employed. This information will be interesting and instructive.

returns the latter to the cutter in a liberal stream, washing out the chips and keeping the cutter and work cool. Means are provided by which the machine is under the full control of the operator in whatever position he may find it most convenient to stand; and the movement of the upright to and from the platen is graduated in thousandths of an inch for setting the cutter to depth, after which operation it is firmly locked in position at the bottom, and at the top by the tie rod.

The engraving on this page shows the latest form of automatic gear cutter made by this concern.

In most of its essential features the machine is similar to its predecessors which we have previously illustrated, but yet some changes have been made, which, in the practical working of the machine, are found to give considerable advantages. The most notable of these changes, perhaps, is in the method of driving. The previous machines were driven by a belt which passed over a pulley that was secured directly to the cutter arbor spindle, and, as this moved during the cut, it was, of course, necessary to provide tightener pulleys, which were counterweighted to keep the belt tension uniform.

In the present arrangement, as shown by the engraving, a separate stand is provided, which carries the driving pulley, with suitable gears and other mechanism for giving motion to the cutter arbor by means of a shaft having a telescopic slide and universal joints. No cone pulleys are used, but changes of speed when required are made by changing one gear on the stand.

There is also provided a support for the outer end of the work arbor, and, where desired, a pump for returning oil to the cutter, the oil as it flows from the cutter being conducted to a pan in the base of the machine, from whence it is taken by the pump, which is shown in the cut at the side of the machine near the floor. In addition to these improvements the entire machine has been more heavily proportioned, and it is now built in sizes calculated for the heaviest work usually done by machine tool builders—for planer gears, etc.

Of course it will be understood that this machine, like the rack cutter, is entirely automatic, and, after being started upon a gear, takes care of itself until it is completed, when it rings a bell to announce the fact. These machines are not only in use among the leading establishments of this country, but numbers of them have been shipped to foreign countries as well, where they have proven very satisfactory.

The "American" System of Manufacture.

BY B. F. SPALDING.

II.

COL. NORTH'S PISTOL MAKING—CAPT. HALL'S BREECH-LOADING RIFLE—DROP FORGINGS—BARREL-TURNING LATHES—MILLING MACHINES, FIRST FORMS—OLD STYLES—IMPROVEMENTS IN WHITNEYVILLE, MIDDLETOWN, WINDSOR, PATERSON, CHICOPEE FALLS—INDEX MACHINES—DRILL PRESSES—RECOLLECTIONS OF GUN MAKERS—THOMAS BLANCHARD—STOCKING MACHINERY—CYRUS BUCKLAND'S INVENTIONS—THOMAS WARNER—SUCCESS ACHIEVED.

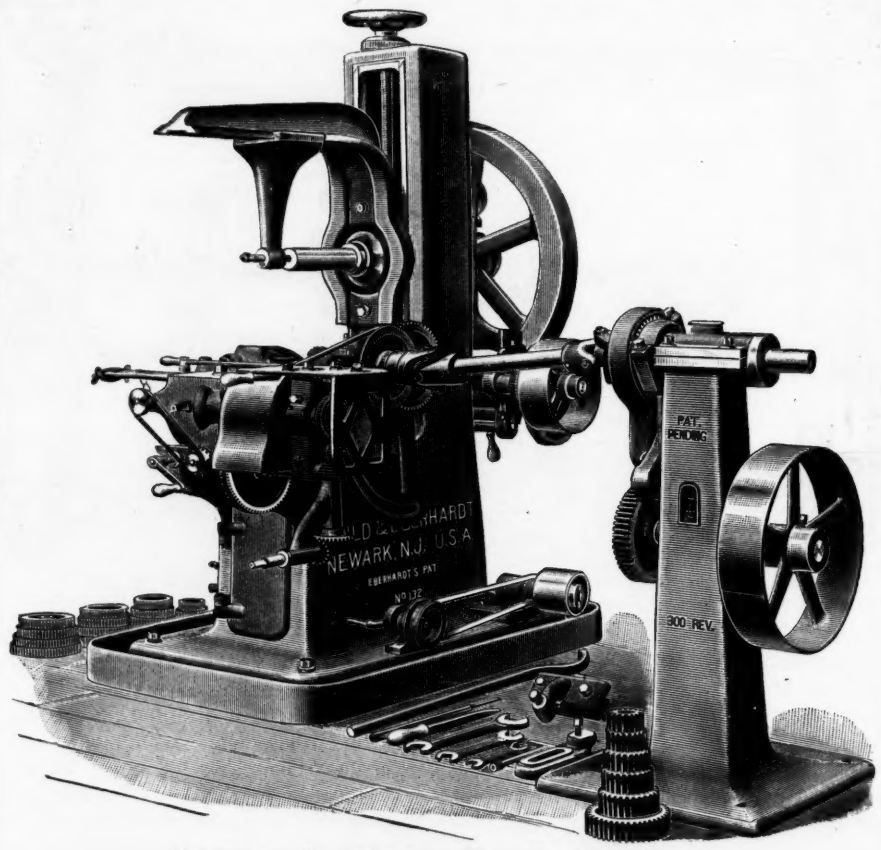
It was thought that some of the serious difficulties which were met with in the attempt to manufacture arms of the United States standard by duplicating machinery could have been avoided if the model had been designed with some regard to that purpose. Colonel Simeon North commenced the manufacture of pistols at Middletown, Conn., in 1814, and attempted, with some degree of success, to make the parts of the lock interchangeable, and also the mountings. John H. Hall, in making a model for the breech-loading rifle which he invented (revived afterwards by General Burnside), constructed it with the express intention of manufacturing it on a large scale, in conformity with the interchangeable system. His work at Harper's Ferry, commenced in 1819, progressed so well that it is on record that in a test made in 1827 with 100 of the rifles which had been made in 1824, they were taken apart, thrown into a promiscuous pile together, and subsequently remounted at random, the parts fitting one gun as well as another. It appears, however, that the rifles were not generally made to conform to this system, from the fact that the armorers who did the repairs on them after service in the field generally failed to recognize the principle of interchangeability, which they could not have failed to do if most of the guns had been made to it.

The contributions of Hall's experiments were largely in the way of securing uniformity in the forgings, by the method of stamping them in dies, used in drops. The practice of shaping iron in dies is of ancient origin, samples of ornamental work being in existence which show, beyond doubt, that they were made by this method. Hall's improvement consisted in the use of a very heavy blow with dies rigidly guided to strike always in the same place, so that the impression in one would match with its mate when the two struck together. This drop had chain connection with a clutch.

The production of special machines was increasing rapidly. In 1818 four patents were taken out in different sections of the country for turning gun barrels; that of Asa Waters, of Millbury, Mass.—invented some years before by Thomas Blanchard—survived as a special duplicating machine. Although this is a matter of record, yet it is a fact that in 1860, when Thomas Warner made the Greene rifle barrels at the Millbury armory, there was not a vestige of a gun barrel lathe there, and he fitted an ordinary lathe with the special appliances for the purpose.

Such facts as these tend to substantiate the stories which have come down to us of milling machines, drill presses, and other machines, which were said to have been used by the early gunmakers, but of which no relics remain. Captain Hall's machinery was broken up when the government ceased to manufacture his arms. Even the milling machines—which were built on the superfluous metal plan, which has received different terms of designation, and were about three times as heavy as those which have come into general use—went to the cupola. It has been asserted, and with great plausibility, that the life principle of the interchangeable system is the rotary cutter. The statement may be put into another form by saying that without the use of circular cutters the production of uniform work would not be practicable. The teeth of these cutters are a series of cutting tools which follow each other continuously. Their use enables successive cuts to be made which are just alike. The number of uniform cuts which can be made with one of these cutters greatly exceeds the number of teeth multiplied by the number which any single-toothed cutter can do. Part of this extraordinary durability is to be credited to the comprehended, but unexplained, relief of rest: part of it to the relief of motion and escape from direct stress; in all, this endurance, permitting a great number of pieces to be shaped at the expense of the nice adjustments which would otherwise be accorded to each piece, scales down the price of the number greatly below that of an equal multiple of the cost of a single one, and thus contributes to the value of the system the element of economy of production, and this has made it a success.

The milling machine, which depends for its efficiency upon its rotating cutters, dates back to the beginning of the century. The first form was very simple. Some idea may be formed of them from the general run of machines then in use. Mr. Cyrus Buckland describes a machine he saw in use in Chicopee Falls in 1823, when the cotton-mills were being built. It was for fluting cotton feed rollers, and operated rather on the principle of planing than milling. He says: "Its frame was like an ordinary engine lathe with ways each side upon the top. The roller to be fluted was fixed on the frame, subject to a rotary motion. The tool-stock traversed on the aforesaid ways, made its cut through, and returned. When it returned it turned the roller automatically for the next flute. The tool-stock was carried forward and back by a very ingenious device. It was moved by a crank working in a slot so formed that it carried the tool forward slowly, and returned it rapidly. The arm of the curved slot was jointed overhead, and the end below the slot was jointed to the tool-stock."



AUTOMATIC GEAR CUTTING MACHINE.—SEE PAGE 1.

Mr. E. E. Lamson, of The Jones & Lamson Machine Co., Windsor, Vt., said, in 1883: "There was here until recently an engine lathe with a bed of stone, on which was laid thin iron plates, upon which the ways were formed. A wooden frame served for legs. The head and tail-stock, and carriages, were almost identical in style with those of lathes, having iron beds, which were said to have come from Chicopee, probably between 1840 and 1850, and nearer the first date. The lathe with stone bed has been known here since about 1840.

"The straight-legged milling machine ('Windsor pattern') was copied in its main features from the Chicopee Falls milling machines, used here probably before 1851 for the manufacture of arms exhibited in the World's Fair of that year. We have one of them now."

Mr. William H. Miller, of The Miller Bros. Cutlery Co, Meriden, Conn., says: "I first went to work in Colt's Patent Fire Arms manufactory in Paterson, N. J., in 1838, for William Ball—one of the most prolific inventors and designers of machinery I ever knew—and my first job was running a milling machine, which was the first I ever saw. Although different in many particulars from those now in use, and crude, the principle was there. The first milling machine with which I am acquainted was made by Colonel North, of Middletown, Conn., and was still more crude than those I used in Paterson. The improvements were made by William Ball. These machines all had spindles, the boxes of which were stationary in the head. The work was brought up to the cutters by means of set-screws in the fixtures on the carriage. The next improvement I saw was in the shop in Chicopee Falls, also by William Ball, who designed what is called the Chicopee Falls milling machine, in which the spindle is raised and lowered to the work. These machines were made for the manufacture of the Jenk's Carbine in 1841. The 'Index,' or 'Dial' milling machine was also used in Paterson, and re-designed and improved by William Ball, and built at Chicopee Falls as now used." The "screw" machine or "cone" machine, as it was sometimes called, was also used at Paterson, and was the first machine in use for making gun screws from wire—they were always forged previous to that time, and for some time after. This machine was also reproduced at Chicopee Falls. The application of the turret head "revolving in a horizontal plane" (invented by H. D. Stone) was made at the shops of Robbins & Lawrence, Windsor, Vt., as has been stated by Mr. Lamson.

The drill press was also used in Paterson. It had been used at Whitneyville by Eli Whitney, and also at the gun shops at Middletown. They were made mostly of wood, each spindle having a separate table. This was greatly improved at Chicopee Falls, but the first drill press with one table to more than one drill was made at Windsor, Vt., by Robbins & Lawrence.

If the propriety of tracing the development of a few machines in a limited locality is questioned, if it be said that their origin is of provincial, and not of general interest, if it is asserted that in England, Germany or France, machines for performing similar operations were in existence, the reply may be that at the time the interchangeable system was first adopted at the Springfield armory its essential ideas were forcing themselves in there from all surrounding points as into a common center; that as to the relation which other machinery in more distant localities may have had to the demonstration of the practicability of this system, there is none perceptible; that even if it could be proved that this system had some time and somehow been tried, proved successful, and abandoned, that fact would not militate against, or take from the importance of these machines, for it is to these, and not to others; it is to the work that these machines did do that the system of interchangeability owes that demonstration of its practical value which caused it to be preserved or actually to continue. Every start before this was abortive, and came to naught. This is the one, and this is the only one that lived, begat progeny, and is the head of a line. These machines, or their lineal descendants, in their full series or sets for making guns, were ordered and made in this country for England, Russia, Prussia, Spain, Turkey, Sweden, Denmark and Egypt, and thus the system, to which they gave vitality, propagated itself in every civilized country throughout the world. It was for such doings as these that the term "American" was bestowed upon the system, and it was a title earned, won and granted in the open field.

Gear cutting machines, using rotating cutters, had long been in use, and some of those old wooden framed machines had remarkably perfect index plates, and they made practically perfect work. They contained the essential features of milling machines,

but required some modification to adapt them to the new purpose. It may be inferred from the name "slabbing" machine, which stuck to the milling machine for a long time in some localities, that their principal use at first was in making flat cuts.

As a not very distinct impression, a crude milling machine which I saw long ago in one of the old gun factories, presents itself to my memory as consisting of a wooden frame, legs of the same material, standards of the same, rising about a foot from the frame; a shaft across the machine ran in boxes, let in and bolted to the standards; the driving pulley (there were no gears) was outside of the frame, and the cutters were inside on the shaft; the teeth on the cutters were very fine, not more than $\frac{3}{16}$" apart; on the frame were screwed cast-iron ways, and on these moved an iron platen, to which was attached the fixtures for holding the work. This platen was moved by a winch on a shaft geared to a rack on the lower side; the fixtures were packed to the right height, and there was no other adjustment.

But if one part can be said to be more essential than another, where exactness in all is indispensable, the wood-working machinery used on the full length stocks of guns played the most important part in carrying out the interchangeable system. The lock, barrel, guard, etc., were separate and distinct combinations of parts, complete in themselves, but only of use as the components of the gun, when they were properly combined by fixing them in their relative positions in the stock. The stock was the frame. It was necessary that it should be made so that every piece would fit into it in its proper place. This is the task which Thomas Blanchard commenced to perform in 1812.

He was doing this while America was fighting England for "sailors' rights," and laying deep the foundations of that maritime ascendency which she afterwards gained—and lost.

Wherever shoe lasts, wheel spokes or axe handles demand the use of the Blanchard lathe, or carving machinery performs its intricate ornamentation, there may be found the results of this undertaking. Thomas Blanchard was at the armory setting up and putting in operation a lathe he had constructed for turning gun barrels which had a flat side, and this it turned as well as the round part, and, as it worked excellently, one of the stockers cried out: "Well, Blanchard, there's one thing you can't do!" "What's that?" he inquired, half looking up from his work. "You can't turn a gun stock!" the man replied with a short laugh. "I don't know about that!" quietly remarked Blanchard, quickly knitting his brows as he again bent over his work. As he was driving home through the woods, in the dusk of the evening, some wood-choppers, who observed him, thought he was crazy when they saw him jump up in his wagon, and exclaim: "I've got it! I've got it!" This may be simply Colonel Asa H. Waters' New England version of the "Eureka!" business, but Blanchard got the "it" patented September 6, 1819. "It" was the lathe for turning irregular forms.

Mr. Blanchard not only built the lathe for turning the gun stocks, but he devised many other machines for working upon the stock. It is believed that he finished his work at the armory, and turned his talents entirely in other directions—to stern-wheel steamboats, methods of bending heavy ship timbers, etc. It is certain that at the date of a report made in 1827, the stocking machines had increased to the number of sixteen.

This original and ingenious machinery of Blanchard's contained the germ of what Cyrus Buckland afterwards amplified and extended, by additions equally as original and ingenious, into a series of duplicating machines which insured uniformity of the stocks. From 1840 to 1852 he designed and built a number of intricate and thoroughly adapted machines, which substituted exact machine work for hand-fitting.

Such was the progress in the improvement of machinery, and its extended application, that the time arrived in 1839 when it was not impossible to produce interchangeable work on a practical basis.

In this belief Mr. Thomas Warner, master armorer at the Springfield armory, applied to Superintendent John Robb for permission to undertake it, and, having the encouragement of Colonel Talcott, general inspector of United States armories and arsenals, he inaugurated the movement. Mr. Fitch says: "Arms completely interchangeable (excepting the breech screw) were turned out in quantities in 1840. In 1852, Cyrus Buckland, master mechanic at the Springfield armory, completed the uniformity of the United States musket by devising machinery for making the breech screws interchangeable. Then rapidly followed the dissemination of the system throughout the armories of the world, and its application to making sewing machines, watches, locomotives, agricultural machinery, and many other products of high industrial consequence, which could not possibly be made and used as at present, but for the improvement in cheapness and quality resulting from this system of manufacture."

Odontics, or the Theory and Practice of the Teeth of Gears.

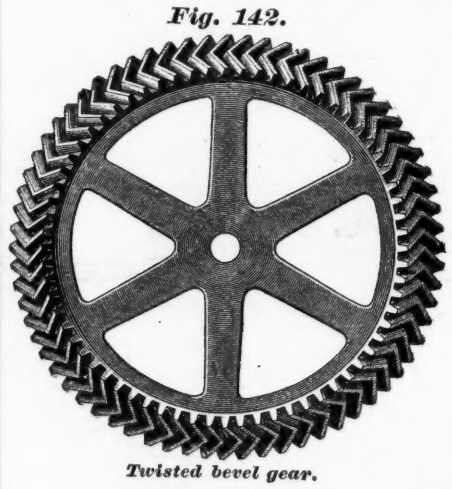
By Geo. B. Grant.

SIXTEENTH PAPER.

154.—THE BEVEL GEAR.

The theory of the bevel gear cannot be properly represented, and can be studied only with the greatest difficulty, upon a plane surface, as it is essentially spherical in nature, and should be shown upon a spherical surface, as in Figs. 143 and 144.

Fig. 142.



Twisted bevel gear.

This is best done upon a spherometer, which is simply a painted sphere fitted in a ring. The sphere rests upon a support, so that the ring coincides with a great circle upon it, and the ring is graduated to 360°. A very roughly made wooden sphere and plain ring will be found to answer the general purpose very well, and should be provided if the study of the bevel gear is seriously intended. If painted, ink marks can be scrubbed off, and pencil marks removed with a rubber.

The mathematical treatment is unapproachable without a knowledge of the common principles of spherical trigonometry.

A wide, interesting, and difficult field of study is offered, but space will permit but a brief examination of the more prominent and practical points. A careful examination would require ten times the available space.

155.—THE GENERAL THEORY.

When thus represented upon the spherical surface, the theory of the bevel gear is so similar to that of the spur gear, as represented upon a plane surface, that any detailed description would be mostly a repetition of what has already been stated.

All straight lines of the spur theory are represented by great circles, the crown gear being the rack among bevel gears, and all distances are measured in degrees.

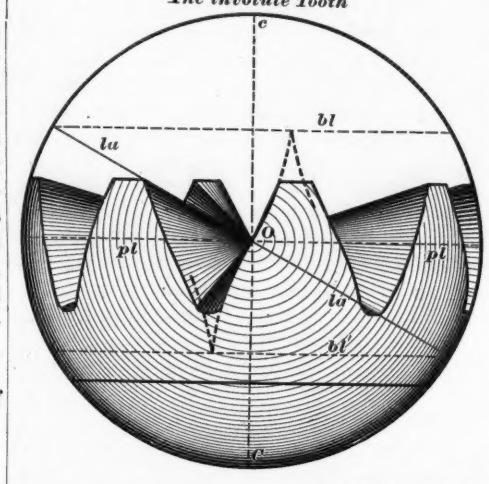
Irregular pitch lines and multilobes are managed substantially as for spur gearing. The elliptic bevel gear will be described in connection with elliptic spur gears.

The body of the bevel gear is generally formed by drawing straight lines from the spherical outline to the center of the sphere, as in Figs. 143 and 144, the pitch lines and tooth outlines being the bases of cones with a common apex.

When limited in width, as is usually the case, it is by a sphere concentric with the outside sphere, so that a spherical shell is formed.

These concentric spherical shells can be moved on their axes to form twisted and spiral teeth, Fig. 142, precisely as described for spur gears (99).

Fig. 143.
The involute Tooth



The molding process of (27) will apply perfectly, but it has but one practical application.

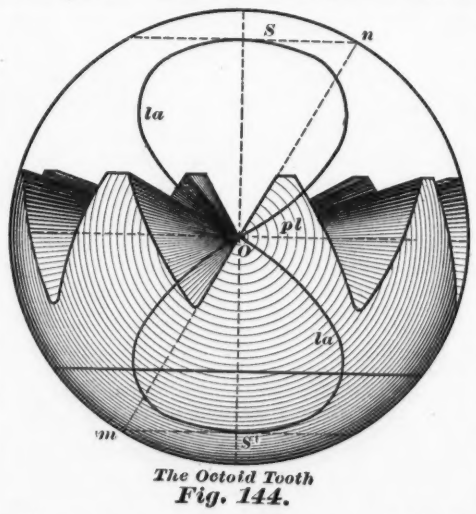
The planing process of (28) will fail, for practical purposes, except for one particular form of tooth, because the shape of the cutting tool cannot in the general case be changed in form as it approaches the apex, and therefore the tooth will not be conical.

The planing process of (29) will apply perfectly, the strokes of the tool being radial, and on this method we must depend for the accurate construction of all forms of bevel gear teeth except the octoid and the pin tooth.

As the diameter of the sphere is increased, the radii become more nearly parallel, until, when the diameter is infinite, they are parallel. Therefore the spur gear is a particular case of the bevel gear, and all formulæ and processes that apply to the bevel gear will apply to the spur gear if the diameter of the sphere is made infinite. The most scientific method of study would be to develop the theory of the bevel gear, and from that proceed to that of the spur gear, but such a method would be difficult to clearly carry out, and is best abandoned for the more confined process here adopted.

156.—PARTICULAR FORMS OF BEVEL TEETH.

As in the case of spur gearing, there can be an infinite number of tooth curves for bevel gearing (31), each form having its own line of action, but as there are only four forms that are available for practical use by means of simple processes of construction, our attention will be confined to them.



The Octoid Tooth
Fig. 144.

These four particular forms are, first, the involute tooth, having a great circle line of action; second, the cycloidal tooth, having a circular line of action; third, the octoid tooth, having a plane crown tooth, and a "figure eight" line of action; and, fourth, the pin tooth, for which one gear of a pair has teeth in the form of round pins.

157.—THE INVOLUTE BEVEL TOOTH.

The spherical involute must be studied as a whole if its form is to be clearly seen.

Its definition is that it is the tooth curve having a great circle for a line of action. In Fig. 143 the great circle line of action *la* extends around the sphere at an angle with the crown pitch line *pl*, and it is tangent to two base lines *bl* and *bl'*, that are parallel with the crown line.

The most convenient method of drawing the tooth curve is by rolling the line of action on the base line, while a point in it describes the curve on the surface of the sphere. The equivalent graphical process is to step along the base line and any two tangent great circles, from any point on the curve to any desired point.

It will take the form shown by the dotted lines, rising at right angles to the base line; it curves until the crown line is reached, there reversing its curvature and bending the other way until it meets the other base line. At the base line it has a cusp, and rises from it to repeat the same course indefinitely.

Fig. 143 shows a crown gear or rack. The pitch line is the great circle *pl*. The line of centers *cOC* is a great circle at right angles with the crown line *pl*. The line of action is the great circle *la* set at a given angle of obliquity with the crown line. The base circles are the small circles *bl* and *bl'*.

The spherical involutes have the same property of adjustability as have the spur involutes, the motion being confined to the sphere, and therefore the gears are adjustable as to their shaft angle, the apex remaining common to both.

158.—THE CYCLOIDAL BEVEL TOOTH.

The definition of the cycloidal tooth is that it is that form which has a circular line of action.

The rolled curve method of treatment (32) applies, and is the best means of studying the curve.

There is no gear with radial flanks, the flank formed by a roller of half the angular diameter of the gear being nearly but not exactly a plane.

The theory differs so little from that of the spur gear, that but little of interest can be found, and the curve will not be considered further.

159.—THE OCTOID BEVEL TOOTH.

The definition of this tooth system is that it is the conjugate system derived from the crown gear having great circle odontoids.

In Fig. 144 the crown gear has plane teeth cutting the sphere in great circles, *mOn*, while a pinion would have convex tooth curves conjugate to the great circles of the crown tooth.

The line of action, from which the tooth derives its name, is the peculiar "figure eight" curve *la*, which is at right angles to the tooth curve at the crown line *pl*, and tangent to the polar circles *S* and *S'*, to which the great circle crown odontoids are also tangent.

This tooth owes its existence to the fact that it is the only known tooth, and probably the only possible tooth, that can be practically formed by the molding planing process of (28). The cutting edge of the tool being straight, no change is required while it is in motion except in its position, and that is accomplished by giving it a motion in such a direction that its corner moves in the radial line of the corner of the bottom of the tooth space.

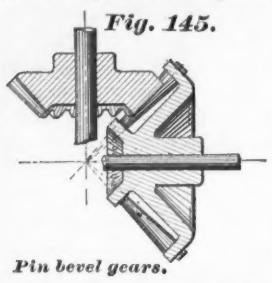
The octoid tooth, together with an ingenious machine for planing it, was invented by Hugo Bilgram, but it has always been mistaken for the very similar true involute tooth. Bilgram's machine is described in the American Machinist for May 9th, 1885, and in the *Journal of the Franklin Institute* for August, 1886.

160.—THE PIN BEVEL TOOTH.

If the tooth of one gear of a pair is a conical pin, Fig. 145, with apex at the center of the sphere, that of the other will be conju-

gate to it, and the combination deserves notice because it is one of the few forms that are easily constructed. It may be said that its practical construction is simpler and easier than that of any other form of bevel gear tooth except the skew pin tooth of (180).

Fig. 145.



Pin bevel gears.

The tooth is preferably, but not necessarily, of the conical form, for other forms of circular pins would serve the theoretical purpose.

Its theory is, in the main, the same as that of the spur pin tooth. It has the same troublesome cusp, which can be avoided in the same way, by setting the center of the pin back from the pitch line.

It is the only known form of tooth that can be formed in a practical manner by the molding process of (27). If the cutting tool is a conical mill, it will form the conjugate tooth while the two pitch wheels are rolled together.

The pins may be mounted on bearings at their ends, forming roller teeth. They would be weak, but would run with the least possible friction, all the rubbing friction being confined to the bearings.

161.—TREDGOLD'S APPROXIMATION.

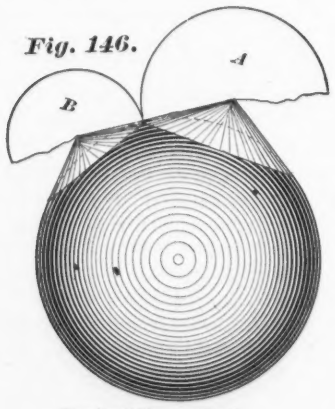
The construction of the true bevel gear tooth curve upon the true spherical surface is impracticable with the means in ordinary use, and the true method of computation by means of spherical trigonometry is equally unfitted for common use. But, by adopting Tredgold's approximate method the difficulties can be overcome.

By this method the tooth curves are drawn, not on the true spherical surface, but, as in Fig. 146, on cones *A* and *B* drawn tangent to the sphere at the pitch lines of the gears. The cones are then rolled out on a plane surface, and the gear teeth drawn upon them precisely as for spur gears of the same pitch diameter.

Practically correct tooth curves could thus be drawn on the spherical surface by cutting the teeth to shape, and bending them down to scribe around them, but in practice the back rims of the gears are shaped to the tangent cones so that the teeth lie directly upon the conical surface.

This method is called approximate, but its real error would be difficult to determine, and is certainly not as great as the inevitable errors of workmanship of any graphical process. The tooth outline drawn by it upon the spherical surface may be considerably different from that which would be drawn directly upon it, but it does not follow that it is therefore incorrect. The only requirement is that the engaging curves shall be conjugate odontoids, and it is a matter of very small consequence whether or not the

Fig. 146.



Tredgold's method.

curve on the sphere is the same kind of curve as that upon the cone. If the true plane involute curve is drawn upon the developed cone, the corresponding curve on the sphere will not be an exact spherical involute, but its divergence from some true odontoidal shape must be minute, even when the teeth are very large indeed. In ordinary cases it cannot be sufficient to affect materially the constancy of the velocity ratio. What is sometimes given as its error is mostly the "difference in shape" between the plane and the spherical teeth.

162.—DRAFTING THE BEVEL GEAR.

The practical application of Tredgold's method is illustrated by Fig. 147.

Draw the axes *CA* and *CB* at the given shaft angle *ACB*. Lay off the given pitch radii *a* and *b*, and draw the lines *c* and *d* intersecting at the pitch point *O*. Draw the center line *OC*, and lay off the face *Of*.

The pitch diameters are *ON* and *OM*, and *NCO* and *MCO* are the pitch cones.

Draw the back rim line *OD* at right angles with the center line, lay off the addenda *Oe* and *Og*, and the clearance *gh*. Draw the front rim line parallel to the back rim line.

The center angle is *X*, the face increment is *F*, and *W* is the face angle. The cutting decrement is *J*, and *Y* is the cutting angle. Twice the distance *mn* is the diameter increment, and *em* is the outside diameter.

The pitch radius of the Tredgold back cone is *OD*, and the figure shows the construction of the gear teeth on this cone developed. The teeth are represented as drawn upon the figure, but it is better to use a separate sheet. The odontograph should be used, calculating the number of teeth in the full circle of the developed cone.

The last air ship is to be built at Chicago. The capital stock is only $200,000, but the ship is to be a big thing—of course—and, as is usual, the ship is to be cigar shaped, *et cetera*. The "elevating wheels" are to be four in number, and they are to turn up at 1,000 revolutions. The dispatch that gives the figures relating to this remarkable ship may as well be quoted; it probably gives the whole idea better than it can be epitomized. Here it is:

Each ship wheel, the inventor estimates, has a lifting power of four tons. The ship itself will weigh but 25,000 or 30,000 pounds, and with four wheels, each having the power to lift four tons, and with the auxiliary assistance of the hydrogen gas, Mr. Atwood thinks he can lift his ship. Once elevated, it is an easy thing to propel it. All about the ship is a perfectly smooth plane, a deck having a surface of 100,000 square feet. This alone would scale the air in an oblique direction, up or down, like a kite. The ship will be built of aluminum, the lightest metal known. It will be 305 feet long, 50 feet high, and 50 feet wide. The hydrogen gas will be manufactured on board the ship. Steam will be the motive power, and gas the fuel.

A Boiler Making Firm Proposes to Insure Its Employes.

The Brownell & Co., boiler makers, of Dayton, Ohio, issue the following, which explains itself:

TO OUR EMPLOYES.

Considering the fact that accident insurance has become a very popular and useful protection, as it provides for us all and our families in case we are injured or killed, we have, at quite an expense, completed arrangements so that we can offer one and all of our employes, insuring them their regular wages, covering a period of fifty weeks, in case they are injured, and the payment of one year's wages if killed.

This insurance covers you, no matter how you are injured, whether you are at work or at home, on the street or elsewhere, you will at all times be protected by the above insurance, so long as you are in our employ. This insurance will be furnished you through us at the very low rate of $6.00 per year. But in order to grant these rates to you, we will be obliged to enroll the names of all of our employes. We hope that you will all take advantage of this offer, and report your names at the office as soon as possible. We shall be glad to favor you by giving time on the payment of the $6 premium of your insurance.

Any further information regarding the matter will be given you by calling at the office, or by the superintendent of your department. THE BROWNELL & CO.

Sketches of an Apprenticeship.

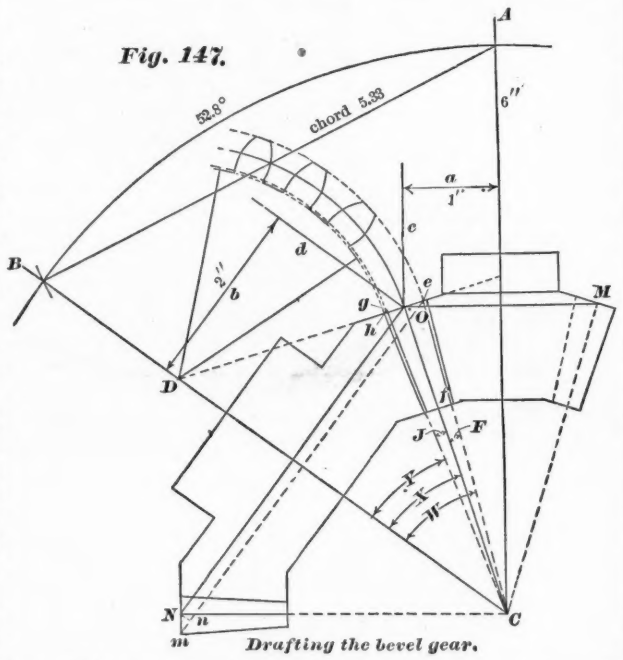
BY W. S. ROGERS.

VII.

One thing our shop lacked was "Rules and Regulations." There seemed to be a mutual understanding between the big whistle and the men that they would begin and leave off together. Neither were there any signs sticking around forbidding us to "spit on the floor, look out the windows, or whistle," or a thousand and one other things almost as silly. Matters seemed to glide along, as it were, without a ripple of trouble.

In my rambles around in other shops during my half-days off, I would come in contact with the "Rules and Regulations," the first one of which generally was to the effect that employes must not talk during working hours, and that visitors were forbidden. One instance I recall, on account of its size, was where the rules were on a sheet of paper about the size of a circus poster, and pasted on the office door that led to the shop room. There were thirty-nine of them (rules and regulations), and as they were on the inside of the door, they helped to pass the time very nicely while waiting for permission from the owner to go through the works. Well, as I walked around among the men and machinery in that place with the proprietor's words of caution "not to infringe upon the rules"

Fig. 147.



Drafting the bevel gear.

ringing in my ears, there was a nameless sort of dread came into my boyish soul just like—— Did you ever go through a graveyard at midnight? Well, that's just the way I felt, and I soon slipped out through the engine-room door and went home with such a subdued sort of demeanor that my paternal ancestor concluded I had been into mischief, and wanted to thrash me anyway.

Next morning, on arriving at the shop, I told the old man my experience, and suggested—(by the way, I would like to remark right here that we cubs were eternally making suggestions to the old man; in fact, he encouraged us to do so, as "it kept us busy thinking"; not that he ever adopted a single one that I ever made, so far as I remember)—well, I suggested that we ought to have some rules pasted up in our shop. He favored my idea, it seemed, and proposed that I spend my leisure evenings in formulating the proper kind for our use. My goodness! but didn't my face burn and my head swell as the old man left me! No use of my bothering about my future career as a machinist. I would show the boss the proper rules to work to.

At the end of a week, by sitting up late nights, I finished those rules, and laid them before the old man; and as he twirled them in his fingers (he didn't read them) I learned my lesson. "My boy, will these rules apply to you?" he asked. "N-o, sir," I replied. "Will they apply to me?" he again inquired. "No, sir," I answered. "Will they apply to any of the others here?" "I think not." "To any who *have* worked for us?" "Yes, sir." "But, you see, those men don't work here now, so the rules could do them no good. An honest mechanic and intelligent, as every one should be, needs rules and regulations no more than does an honest employer. Rules are good among a miscellaneous class of workmen, but you will find that there is usually continual concealed attempts at cheating between employer and employe in a machine shop governed by iron-bound rules. I guess we don't need any rules."

The old man was right. I have seen it tried both ways. In the shop where I am to-day there are no "rules," and absolute harmony prevails. Once in a while some worthless, noisy, careless chap gets a job, but he soon drops out, and goes where he can be "ruled," and spend his time scheming how to beat the boss, while probably the boss is figuring the same way to cheat his man. There is a sort of attraction between them. No, we don't need any rules, except the golden one.

On Contracts.

The question of rights and liabilities under contracts made by correspondence, or a series of letters or telegrams to and from some one in another city in relation to mutual business transactions, is one that is frequently arising in business life, and with the principles of law governing such contracts or such correspondence, it will be advantageous to most business men to be familiar. Contracts thus made are in their nature the same as all other contracts, and governed by the same rules, viz.: There must be parties capable of contracting, a subject matter to be contracted for, a sufficient consideration, and an assent or completion of the contracts, and it is of the rules governing the determination of this question only that we propose to write now, and to give only those more familiar rules that are well established by adjudicated cases.

An offer made by mail or telegraph is a continuing and open proposition until its receipt by the party to whom it is addressed, and such reasonable time thereafter as will enable him to accept or refuse it, or until actual notice of its withdrawal by the party making the offer reaches the party to whom the offer has been made; and any act done by that party evincing an intent to accept it before actually receiving such notice of its withdrawal, is a completion of the contract. It may be withdrawn by the party making it at any time previous to its acceptance by the other, but this notice of withdrawal is not operative until it has actually reached the party to whom it is addressed.

For instance: If A. should write to B., making a certain offer for certain goods, and B. should write accepting such offer, the contract would be completed at the time B. posted his acceptance, although A. might, in the meantime, have written another letter withdrawing his offer, providing that B. had mailed his acceptance before receiving the notice of withdrawal. In other words, the contract is complete at the time of mailing the acceptance of the offer, and not at the time of the receipt of such acceptance by the party making the offer.

Should B. delay his acceptance, however, until the receipt of the notice of withdrawal, no acceptance then made could operate to bind A. to the contract.

The offer need not be revoked in the same manner as it was made, either; and should A., after making an offer to B., alter his determination and telegraph B. to that effect which telegram was received by B. previoue to a receipt of the offer or its acceptance by him, it is a complete withdrawal.

The entire question in each case is, has there been an assent to the terms offered before the offer was withdrawn? If so, there is a complete contract, which can only be rescinded by the consent of both parties, while before such acceptance its terms are constantly open to a modification by either.—*The American Merchant.*

It is said that an Australian photographer secures excellent pictures at a distance of sixteen miles.

A New Process for Generating and Cutting the Teeth of Spur Wheels.

BY AMBROSE SWASEY, CLEVELAND, O.

(A Paper Presented at the Richmond Meeting of Mechanical Engineers.)

The theory of the interchange system of gearing according to the solution first given by Professor Willis, in his treatise on the "Principles of Mechanism," is, "that in a set of wheels of the same pitch, having a constant generating circle for the flanks and faces of the teeth, any two wheels of the set will work correctly together"; and as a rack is a gear so infinitely large that its periphery forms a straight line, it follows that, if the rack teeth are also described with the same circle as that used for the wheels, any one of the set will run correctly with the rack.

The diameter of the generating or describing circle which gives one of the best forms of teeth for a set of wheels is equal to the radius of the pitch diameter of a 15-tooth pinion, making a 7½-inch generating circle for one diametral pitch. The flanks of a 15-tooth pinion being radial, a 12-tooth pinion, which is the smallest generally used in practice, will have the flank of one tooth nearly parallel to that of the tooth following, thus allowing the space between the teeth to be cut with the regular gear cutter.

It was thought at the time this system was first brought out, that its use would be very limited, as in the case of change gears for lathes, and where it was found necessary to construct a train of gear wheels; but time has shown that it has many advantages over other equally correct systems not on the interchangeable plan, and it has been constantly growing in favor, until it is now almost universally adopted, especially among those using cut gearing.

Prof. Edward Sang has also solved the same problem in another way, by taking the rack for the foundation of all curves for a set of interchange gear wheels. In the Sang theory, instead of using a constant describing circle, the rack acts as a constant generator, and the faces and flanks of all teeth throughout the whole set of wheels are described by it; therefore it is evident that, if the constant generating circle which is used for a set of wheels according to the Willis theory is also used to form the teeth of a rack, this same rack can be used in accordance with the Sang theory to generate another set of wheels, and any gear of one set will work correctly with the other.

For many years, one of the foremost mechanical problems in gearing has been to reduce these well-known theories to practice, and produce gear teeth having contours that correspond as nearly as possible to the theoretical curves. At first the teeth were drawn on paper or sheet metal, using arcs of circles which approximated the true curves, and then templets were made to these drawings, by which the cutters were shaped; but it was found that cutters made in this way would not give as good results as desired, and afterward curves which were very much nearer the theoretical lines than arcs of circles were laid out by means of Professor Robinson's templet odontograph, and cutters made from them with much better results. Later, the curves of coarse pitch teeth were laid out, and sheet-steel formers shaped to the lines as nearly as possible. These formers were then placed in a pantagraph machine, and cutters of the different pitches made from them; but it was found impossible, even with the large drawings, to make the formers sufficiently accurate. The epicycloidal milling engine was then constructed for generating and milling the curves of one diametral pitch upon a steel plate, and, with these formers as a basis, cutters of any pitch were made. Thus step by step the process of making gearing with special cutters for each wheel, according to the Willis theory of the interchange system, has been brought to great mechanical perfection.

In the new process, which is the subject of this paper, instead of making all gears so that they will run into a rack, the rack is transformed into a cutting tool, and by it the teeth of wheels of any diameter are generated and cut at the same time.

Fig. 76 illustrates a gear generating and cutting engine, designed and constructed by the writer, for the purpose of reducing to practice the principles of this process. The cutters are shown in position as they appear in the machine when the teeth are cut partly across the face of the wheel. The cutting spindles and the main spindle which carries the wheel are connected by means of change gears, the number of teeth to be cut in the wheel determining the proportion between the two on the same principle as the change gears of an engine lathe, which gives the cutting spindle as many revolutions to one of the main spindles as there are teeth in the wheel.

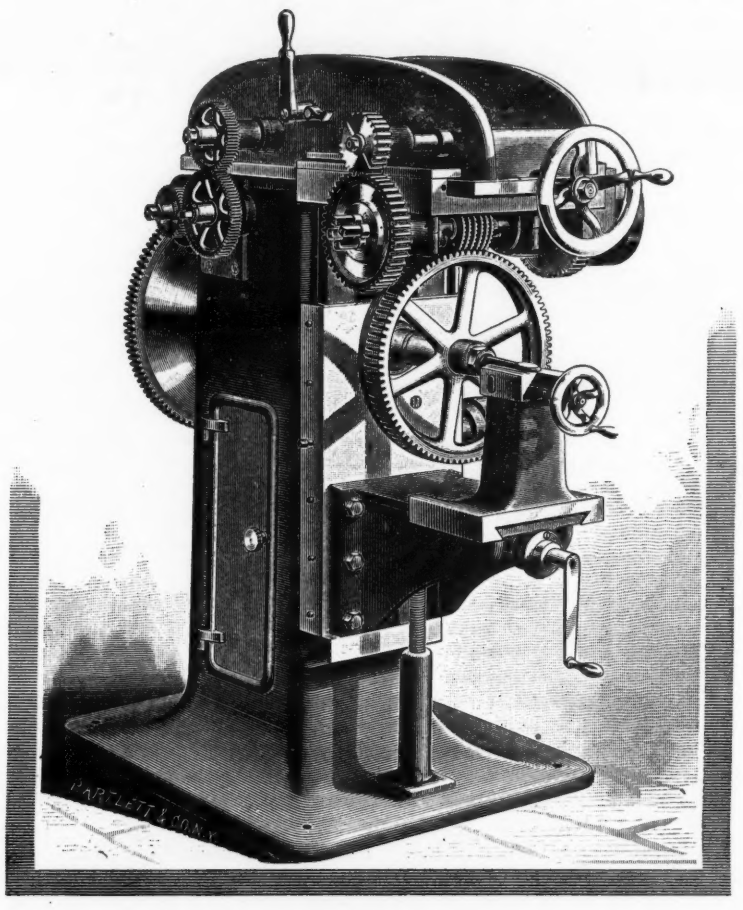


Fig. 76.

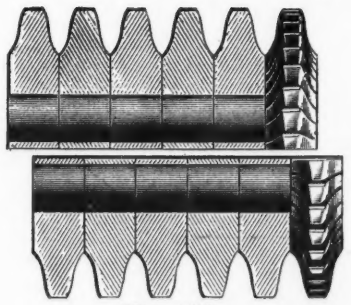


Fig. 77.

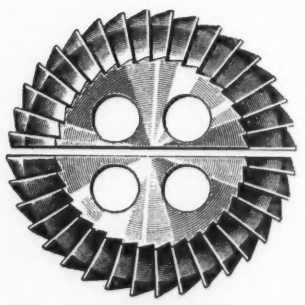


Fig. 78.

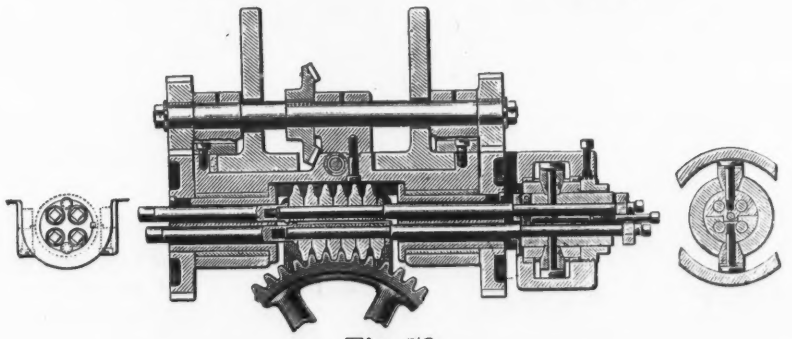


Fig. 79.

SWASEY'S GEAR GENERATING AND CUTTING ENGINE.

The cutting tool is composed of a series of cutters rigidly connected, which revolve, and at the same time move longitudinally or endwise at right angles to the axis of the wheel to be cut; and at the same speed, it is continually revolving at the pitch line, the motions being the same as in the case of a rack engaging with a revolving gear.

As it would be impracticable to continue moving the whole series of cutters endwise, they are bisected, and these segments are connected in series forming two sections, which revolve upon a common axis, and each section is given an independent endwise motion by means of a cam. When one section is engaged in cutting, it is carried endwise in the same direction and at the same velocity that the pitch line of the wheel is revolving, until disengaged from it, when the cutters, while continuing to revolve, are carried back by the cam to their original position, ready for the next tooth. By means of both sections, as they continually revolve and alternately slide forward while cutting, and back when disengaged, there is a continuous cutting and generating process of the teeth in the revolving wheel. The head carrying the cutters is automatically fed across the face of the wheel, and when the cutters have proceeded once across, the gear is completed.

Fig. 77 is a side elevation of a bisected cutter, and Fig. 78 shows a series of six cutters, the end one being in elevation, and the others in cross-section — these having cutting portions, which in cross-section represent the teeth of a rack, with the addition to the diameter of a given proportion of the pitch, by which the clearance and fillets at the bottom of the teeth are made. If their cutting portions are formed of cycloids, then the whole set of gear wheels cut with them will be of the epicycloidal or double-curve system. If they are formed simply of straight sides, then a set of involute or single-curve gears will be generated and cut, or their cutting portions may be composed of both straight lines and cycloids, and produce Professor McCord's recent system of gearing which has composite teeth with the contours partly involute and partly epicycloidal.

All the cutters in a series are made exactly alike and interchangeable, the thickness of each or the distance from the center of one to the center of that adjoining being equal to the pitch of the gear to be cut. As indicated in Fig. 77, the two segments of a cutter are first made whole, with four holes an equal distance from the center, through which the rods pass that fasten them together. After the cutters are nearly completed, they are bisected with a narrow tool, leaving two holes in each segment.

Fig. 79 is a cross-section of the head, showing the mechanism for revolving and reciprocating the cutters. The rods which extend through the cutters serve not only to hold them firmly together, but to revolve them, and at the same time act as slides for the reciprocating motion. The spindles on either sides of the cutters, through which the rods extend, are revolved independently and at the same speed by means of a parallel shaft, having a pinion at each end, which engages with a large gear on each spindle. By this means the four rods carrying the two cutter sections are revolved from each end, thus avoiding the torsional strain which would result if driven from one end only. The pair of rods for each section, after passing through one of the spindles, terminate in semi-cylindrical blocks. From these blocks studs extend, on which are journaled rolls, which engage with a cam which is held rigidly to the head. This cam is shown in

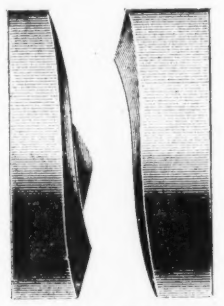


Fig. 80.

Fig. 80, the working portions being made in the form of a screw thread, which, if extended all the way around, would have a lead equal to the thickness or pitch of the cutter. As each section of the cutters engages with the wheel but three-fourths of a revolution, the thread portion of the cam which carries the cutters forward extends only three-fourths of its circumference, leaving the other one-fourth for the reverse curves of the cam to bring the cutters back to their starting point. Provision is made for adjusting one section of cutters so as exactly to coincide with the other, making the spaces and teeth of the wheel equal, or, as is often necessary, the space can be made wider than the teeth by setting one section past the other. The variation in the spacing from one tooth to another is reduced to a minimum, as the series of cutters act upon both sides of a number of teeth at the same time, and serve to average and eliminate any local inaccuracies in the division of the index and driving gears; also to obviate any tendency to crowd the wheel from one side to the other.

The forward motion of the cutters and the revolving of the wheel at the pitch line being exactly the same, the process of generating and cutting the teeth goes on continuously and uniformly around its entire periphery, so that one part is not heated more than another, but all the teeth are cut under exactly the same conditions, and, when the revolving cutters have once passed across the face, all the teeth in the gear are completed and given the correct form for each diameter of wheel; and as by the Willis theory all gears are cut to run into a rack, so by this process the Sang theory is put into practice, and a rack is made to cut correctly all gears.

It is said that there are 120,079 nautical miles of submarine cable in the world, all but 12,534 being owned and operated by private companies. The total cost of these cables is estimated to be $200,000,000.

The Measurement of Power.

By J. J. Flather.

SECOND PAPER.

As the power required to drive the machinery in a modern plant cannot be even approximately ascertained from its relation to the number of men employed, the question still remains open: How can this power be measured?

A method has been suggested by which the power required is to be ascertained from the velocity and width of driving belt. Different rules have been given in our text-books and engineering journals in order to estimate the driving power of a belt from its width and velocity. A "rough and ready" rule which the writer has used in his practice is: Every inch in width of a single laced belt, having a velocity of 800 feet per minute, will transmit one horse-power up to a velocity of about 5,000 feet per minute; beyond 5,000 the centrifugal force of the belt largely diminishes its power. Expressed as a formula we have:

$$\frac{b\,V}{800} = H.\,P.$$

in which b equals breadth of belt in inches; and V equals velocity of belt in feet per minute. To illustrate this let us look at an example. Suppose the main shaft of a factory runs at 125 revolutions per minute, and a 12″ pulley on this shaft drives a 10″ pulley on the counter of a 16″ lathe through a 3″ belt; the lathe is driven by a 2½ inch belt running from a 10″ step to an 8″. What power does the lathe absorb when the belt is taxed to its limit? The speed of the belt is 392 feet per minute—if we disregard slip, which is about two per cent. of the total velocity; this would give

$$\frac{2.5 \times 392}{800} = 1.22\ H.\,P.$$

Now, as shown, the belt will transmit according to our formula 1.22 H. P., and by calculating H. P. for the different machines in the factory a measure of the driving power may be obtained, to which 35 per cent. should be added for power required to drive the shafting, elevators, fans, etc.

This process might give an approximation somewhat nearer the truth than the method previously discussed, but as the formula is based on a certain permissible stress in the belt fibers, which stress is well within the limit of safety, we do not know how much *more* power the belt is exerting, nor do we know that it *is* exerting as much as the formula calls for. Although we can calculate what the width of a belt *ought* to be to transmit a given horse-power x at a given velocity, the stress in the belt may be greater or less than that on which our formula is based, and the resulting horse-power transmitted may be $x + y$.

In order to measure the amount of driving power from the velocity and width of belting, the tension on the tight and slack sides of a belt, the arc of contact α between the belt and pulley, and the coefficient of friction φ are all necessary.

The width of a belt of thickness t must be such that its cross-section multiplied by its permissible working stress f is capable of resisting the maximum tension T_1 in the driving side of the belt, or $T_1 = b\,t\,f$.

We have the general equation:

$$H.\,P. = \frac{P\,V}{33{,}000}.$$

Now if we let $P = \frac{T_1}{m}$, where m is a function of the arc of contact α, and coefficient of friction φ, we obtain

$$H\,P = \frac{b\,t\,f\,V}{33{,}000\,m};$$

if $b\,t$ = one square inch, the horse-power transmitted per 1,000 feet per minute is expressed by $H_0 = \frac{f}{33\,m}$.

This Reuleaux calls the *specific duty* of a belt, the value of which he gives for leather belting, as varying from 5.3 to 9.8, hence

$$\left.\begin{matrix}5.3\\9.8\end{matrix}\right\} = \frac{f}{33\,m}.$$

As f varies in different belts, and m varies with α and φ, it is seen that any general formula, whether rational or empirical, is not trustworthy when the total amount of power absorbed is desired—however satisfactory such a formula may be when used to calculate the width of belt to transmit safely a given horse-power. The only reliable method of determining this transmission of power is by the use of some form of dynamometer.

Where power is rented from one firm to another, the necessity of obtaining correct estimates of the amount consumed is apparent. A case in point is that of the Lowell Hosiery Co., which rented an estimated total of 13½ horse-power, for which $125 per horse-power per annum was paid.

A dynamometer test being made, it was ascertained that 28½ H. P. was being used—more than double the amount paid for. Another case is that of the Northampton Tape Co., whose lease called for 30 H. P.; a dynamometer being applied to the shaft it was found that 11 H. P. was the maximum transmitted. Still another case is that of a company in Worcester, which hired rooms and power, the basis of rent being estimated at 13 H. P. Forty horse-power was actually used, as shown by a dynamometer test, and the rent was increased accordingly.

Many such instances could be cited to show that very wide differences exist between the amount of estimated power and the amount actually developed as determined by an accurate dynamometer. Such wild estimates are at first sight difficult to account for, since there are several good rules in use for ascertaining the width of belt to transmit a given horse-power; however, as already shown, as these rules do not take into account the individual differences in belt tension, there will result, with variations of velocity and tension, corresponding variations of power transmitted.

Mr. Henry R. Towne's experiments with leather belting show that the ultimate strength of a laced belt $\frac{7}{32}$″ thick is about 200 pounds per inch of width; assuming a factor of safety of 3, this gives 66 pounds as the allowable strain per inch of width in single belting (Morin assumes 55 pounds). For a spliced or riveted belt the permissible strain may be 125 pounds per inch of width.

The following table, compiled by Mr. Nagle, gives a list of belts in use, and the actual horse-power transmitted by them, compared with which are calculated widths by the formulæ of Webber, Nagle and Reuleaux—the two latter taking into account the allowable strain in the belt fibers. The widths in the 9th column are calculated from the "handy rule" already alluded to. In the formula used by Mr. Nagle, the coefficient of friction deduced from the experiments of Mr. Towne is assumed at 42 per cent. As this coefficient was obtained while the belt was at rest or had no apparent velocity, the friction between the surface of the pulley and the belt will be somewhat different when in motion, although the experiments made by Wm. Sellers & Co., with belting running at an average velocity of 800 feet per minute, give coefficients varying from 25 per cent. to 100 per cent. Rankine assumes 15 per cent. as the coefficient of friction, but the results of all other investigators show this value to be too low. Morin gives 28 per cent. as an average value for dry belts on smooth cast-iron pulleys, and 12 per cent. for very greasy shop belts on cast-iron pulleys—the mean of these being 20 per cent. Recent investigations at the Massachusetts Institute of Technology show that this mean value is a little low, but probably nearer the truth than either Towne's or Rankine's coefficient. According to these later experiments the value 27 per cent. was chosen as being the best under the average conditions to which an ordinary belt is subjected in practice—allowing 2½ per cent. for slip—and this value has been used in calculating the widths given in column 8, the formula used being

$$b = \frac{1{,}000\ H.\ P.}{1.06\ V} \text{ or } \frac{H.\ P.}{0.106} \times 100;$$

Realeaux' formula, in which $\varphi = 0.28$, instead of 0.27 as here used, is practically the same: $b = \frac{1\,000\ H.\ P.}{1.10\ V}$,

V being in feet per minute.

An inspection of the 4th column shows that the actual strain or belt pull varies from 24 to 135 pounds per inch of width. Considering these varying tensions and comparing the calculated width with those found in actual practice, we arrive at the same conclusion previously reached, viz., that the driving power of a belt is not directly determinable by the use of a formula unless the belt pull or stress is known for each particular case.

WIDTH AND VELOCITY OF BELTING.

Horse-power.	Velocity in feet per minute.	Dia. of Small Pulley in inches.	Belt pull per inch width in pounds.	Thickness.	Width of Belt. In use.	Webber's Rule.	Nagle's Rule.	Reuleaux' Rule.	Handy Rule.
375	5.600	60	98	Double	24	22	34	31½	27
250	3.080	84	58	4 ply	28	50	28	28	23
220	2.451	42	135	Single	32	98	31	34	70
175	3.179	72	93	Double	19½	15½	25	26	22
175	3.629	115½	55	"	29	15	22	23	20
130	2,117	70	113	"	18	18	22	29	24½
125	3.490	84	82	"	14½	8	17	17	14½
90	2,860	60	87	"	12	10	15	15	12½
77	2.268	60	77	"	14½	12	12	16	13½
45	2,000	48	37	Single	20	21	15	21	18
49	2,111	72	24	"	14	21	18	21	18½
43	1,800	60	44	"	18	20	14	23	19
41	1,809	60	42	"	17½	12	16	21	18
40	2,000	72	37	"	8	14	13	19	16
18	850	22	116	Double	6	19	8	10	8½
8	942	30	40	Single	7	12	8	8	7

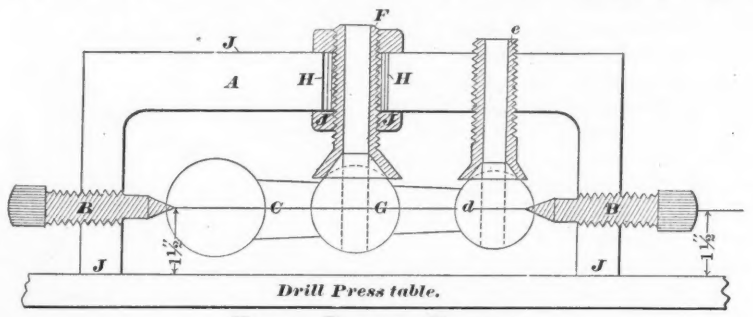
Note.—Columns 9 and 10 have been computed and added to Mr. Nagle's table by the writer.

We have already stated that the only satisfactory method of ascertaining the amount of power is by the use of some form of dynamometer—by which we mean an instrument or machine for measuring the power exerted by a prime mover, or the amount of power consumed in driving a machine or machinery plant.

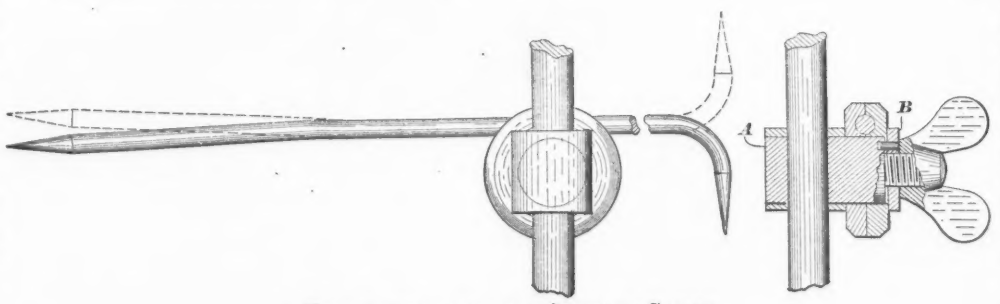
On the side of the Big Black mountain, 300 yards from the Wise County line, in Harlan County, Kentucky, and about ten miles from Big Stone Gap, says the Louisville *Courier-Journal*, there stood, until last week, a tree that is thought to be the most valuable tree in the South Appalachian Mountains, and is, perhaps, without a peer on the continent.

It is curled grain black walnut, and the owner had it grubbed up by the roots, so as not to lose even a chip. It is between five and six feet in diameter at the base.

A New York lumber dealer bought the tree from an ignorant mountaineer for $50, paid a man $300 to move it to the nearest railroad, and thinks he will make a profit of $5,000 from the tree.



Handle Drilling Fixture.



A Fine Adjustment for Surface Gauge.

LETTERS FROM PRACTICAL MEN.

A Fine Adjustment for Surface Gauge.

Editor American Machinist:

I have been using for some time a surface gauge that has a fine adjustment, which combines the desirable features of simplicity, rigidity and convenience in use, and as the adjustment is accomplished in a manner that is radically different from any that I have seen up to date, I thought perhaps it might interest some of your readers, so I will describe the washers that clamp the scriber, as it is in these and in the scriber itself that the chief features lie. The washers were cut out square from sheet steel and soldered together; the hole for the scriber was then drilled and finished with a rose reamer made of the *same sized wire as the scriber*. After this the center hole was made in the washers, and they were turned up round, polished, and then unsoldered. After cleaning off the solder, the washers will bring up solid on their inside faces at the same time that they clamp the scriber.

Although the clamping is tight enough to prevent the scriber from being moved endwise through the washers, or the washers from being rotated on the stud A, the scriber can be twisted in its bearing by grasping its hooked end, as this latter has so much leverage over the comparatively small diameter of the wire. This being the case, a slight bend in the scriber, about one-quarter of its length from the point, would cause its point to run eccentrically when the scriber was rotated in its bearing in the washers, if the latter held it at about its mid-length. The cut of the scriber shows the bend in an exaggerated degree, it being made in the same direction as the hook, the dotted lines showing the parts after the scriber is given a half turn in its bearing. If the hook is set horizontally at first, the point at the other end will then be in the middle of its range of adjustment, and may be raised by twisting the hook up, or lowered by twisting it down. My scriber has about .02 inch range of adjustment, which I found was amply sufficient. However, the scriber may be bent more if necessary, but it would detract somewhat from the looks of the tool, as well as from the sensitiveness of the adjustment. The washer B has a small pin to keep it from turning, which prevents the nut from loosening when rotating the large washers in making the coarse adjustment. If the scriber fits too loose, a few strokes of a smooth file on the inside faces of the washers will fix it, or, if too tight, its hole may be lapped out. The solid contact of the washers and scriber, and also the eccentricity of the latter, I believe to be original with me, although the rest of the rig may savor somewhat of antiquity.

Walter Gribben.

Handle Drilling Fixture.

Editor American Machinist:

Enclosed please find sketch of a jig for drilling ball handles.

Referring to sketch, A represents a frame of suitable length to admit the ball handle, provided with two center point set-screws $B\,B$, fitted snugly into frame A, upon which is suspended ball handle C; e represents a steel thimble bored the size of hole desired through the small ball d. The mouth of thimble

is made conical in form, permitting balls varying in diameter to be placed in proper position in relation to the mouth of thimble; it being funnel shaped, will center a ball when screwed down upon it, as shown in sketch. The screws *B B* are intended for lateral adjustment, until ball *d* is in proper position in thimble *e;* it follows that the hole in thimble *e* will be dead central with the ball. The thimble *F* has a thread cut on the outside to receive jam nuts, one below and one above, which are intended to secure thimble in proper position when centered on middle ball *G*.

It will be seen by referring to sketch, that frame *A* is slotted at *H H*, to compensate for variations in distances of centers.

The frame *A* is planed at *J J J J*, so that the drilling may be done accurately.

I have used this tool with the best results; handles may be drilled by its use with absolute accuracy, and as for speed, I do not desire anything better.

PETER SHELLENBACK.

"For the Good of All."

Editor American Machinist:

As a throttle puller and machinist, I read your recent editorial with the heading I have quoted, with an extra allowance of satisfaction. It set me thinking of some things that might be written between the lines.

In your editorial you refer to two steam plants, in one of which you show that a man of very ordinary ability can get along, while in the other, a man of greater attainments is required. It is sometimes an excellent way, to arrive at conclusions on subjects too large to be grasped entire, to go to extremes. The best way to comprehend that twice two millions is four millions is to reason from the simple and easily understood fact that twice two is four. Now let us, on some such principle, assume that there are only two steam plants in the world, and only two engineers, either of whom could take care of the small plant, but only one of whom could handle the large one. Would not the best interests of the world be served by putting the big man in the big place, and the small man in the place corresponding to his size, to the end that both enterprises might go on? And would it not be remarkably selfish selfishness that should seek to keep the big man in the small place, at small pay, and let the large place go idle and unproductive?

Perhaps you may be able (I don't think you are) to say why the case is different, because, as it happens, there are a good many large places, and more small ones to fill. I am a member of the N. A. S. E., but shall be glad to tender my resignation when that association does not seek to put good men in good places—I mean in responsible places where they have opportunities to work, with the knowledge and skill they possess, for the good of themselves and for the good of the world. Probably I am just as selfish as those who object to the association because it has helped to fit men to places, but my selfishness does not happen to be of the same kind, for which, like the Scribes and Pharisees, probably, I am thankful.

It would be easy enough to argue this question at any length, but it does not seem to be necessary. The world lives through the efforts of those who produce something. With every producer in the position in which he can produce the most, the world will live the better. And the bringing of this about, to a reasonable extent, does not appear to call for much sacrifice on the part of any one. My advice to the N. A. S. E.—for what it is worth—is to put the best men in the best places, every time.

One thing more, Mr. Editor: What do you think of a man who "bosses" the operation of a steam plant, and yet knows no more about it than to imagine that drilling the cylinder for an indicator attachment would injure it? Don't you really believe that such an "excellent business man, and a gentleman, by the way," would do himself and the world better service by sticking—like the shoemaker to his last—to that particular business about which he knows something, leaving those things of which he is ignorant to others who do know?

Put it another way. If you, Mr. Editor, had a little wheezy engine that ought, in the interests of humanity and the eternal fitness of things, go through the cupola and blacksmith shop—or off the dock—if you had such an engine and the balance of plant to correspond; if you had these, and then was so fortunate as to have a progressive engineer—one of those fellows who are always wanting to do better—wanting to find out something of the cause of the wheeziness; given to you all these things, would you encourage that engineer in laudable intentions, or would you sit down on his determination to harness up his indicator—that cost him some weeks' work, and didn't cost you a cent—to harness it up to your old scrap heap that wasn't worth as much as his indicator—in order to save some money for you, and perhaps do him some good? Would you be willing to advertise, by refusing him permission, that you were afraid he might get to know so much that your little job wouldn't be big enough for him? If you did refuse him permission to do this, would it not be rather conclusive evidence that you were afraid he might know too much? Can you—can any one—afford to set up a bar to progress in this world on the strength of a very small personal consideration?

While it is true that men get thrust into places several sizes too large for them, it is equally true that men are crowded into places where too much paring down is required in the process of making them fit. Common sense teaches that the more natural the fit the better the general results. JOEL OLDONE.

Portland Cement for Setting Bed Plates.

Editor American Machinist:

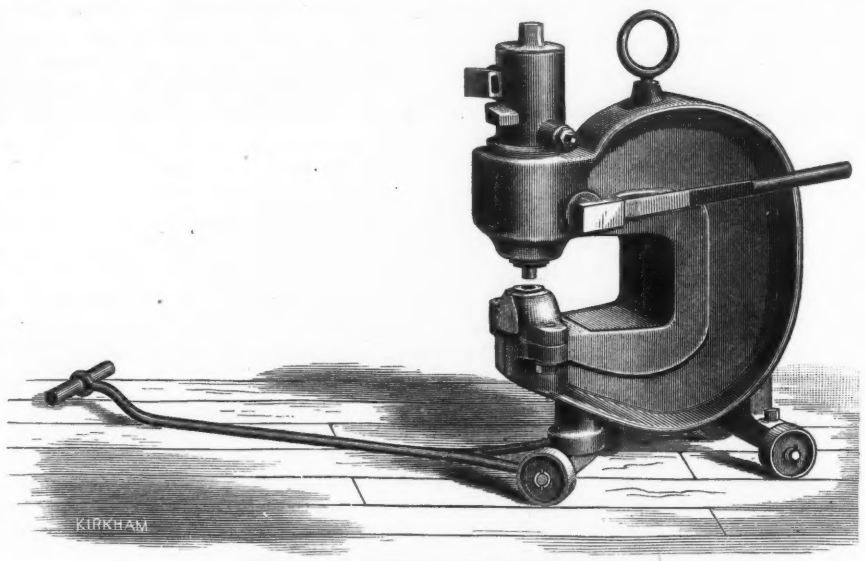
Referring to Question 402, concerning something that will expand in cooling, to be used in setting an engine bed, I have seen clear Portland cement used in setting a battery of four two-million gallon pumps on stone beds. I have also used it successfully in setting base plates for iron columns.

To use the cement, form a dam of sand or clay around the bed to be set, mix the cement with water to about the consistency of cream, and pour it around the bed, working it well under all flat surfaces. The bed must be previously wedged up to position, and the wedges allowed to remain till the cement is set.

Portland cement expands slightly in setting, and is not affected by oil, as is sulphur.

H. J. B.

[Portland cement is very commonly used for setting machinery. In pouring it, we have always found it an excellent plan to build in a stand-pipe six to ten feet high, and to pour through this; doing this gives a "head," and insures the filling of small spaces. Probably this would be a wise precaution when using sulphur. If very much oil comes in constant contact with sulphur, there is no doubt that it will injure the setting. Still we have never known an engine setting seriously injured by this, and we know more than one over twenty-five years old.]



PORTABLE HYDRAULIC BEAM PUNCH.

Contraction of Sulphur.

Editor American Machinist:

The writer some years ago had occasion frequently to use sulphur, for the purpose of obtaining casts of a portion of the interior of rifle barrels, in order to ascertain the exact diameter at the bottom of the grooves, also to detect slight scratches or other imperfections. We found a very perceptible shrinkage in sulphur casts, but overcame a portion of it by heating the barrel to about 150°, which gave us a perfect cast, and by measuring it as soon as possible we got satisfactory results. Still we found that a sulphur cast .452 diameter would shrink .001 when cold, under the foregoing conditions.

F. H. TREACY.

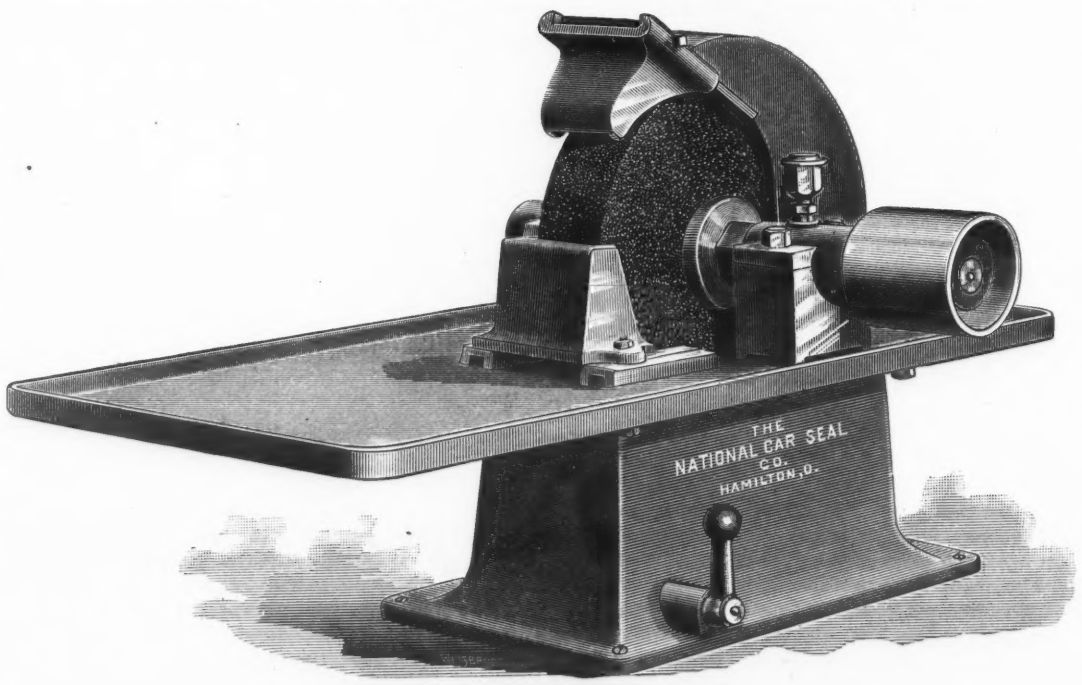
A correspondent writes us: We have to make a cast-iron die 3″x14″x20″, which must be chilled on its front face, leaving the back soft enough to be machined. We have made a chill something like those used in making car wheels, water circulating through during the pouring and afterwards. We have tried the best car wheel scrap with very poor success; have never been able to get a casting so hard that it could not be indented by a hammer blow. Can any of your readers suggest a mixture of iron that will give better results?

Portable Hydraulic Beam Punch.

We present herewith an illustration of a punch which is operated by a pump worked by a lever which is inserted in the socket on the side of the head. One movement of the lever shown withdraws the punch entirely from the iron. The body of the machine is of steel, and the throat is nine inches deep by six and a half inches high, allowing holes to be punched close to a flange or nine inches from the edge. It also allows T-iron to be punched without pushing it lengthways through the machine. The punches are prevented from turning, thus permitting of the use of irregularly shaped dies without danger of the punch striking the die. The ring is put in the top of the machine for lifting or suspending it when the work is such as to require this. All the parts are made as simple as possible, and easy of access The head may be turned in any direction, so that the lever may be worked from any desired position. The machine illustrated weighs 525 pounds, and heavier ones of the same design are built to order by the manufacturers, Watson & Stillman, 204 East Forty-third street, New York City.

Bench Tool Grinder.

We give on this page an illustration of a tool-grinding machine, intended to be set on a bench, and which uses wheels twelve inches diameter, two inches thick. The water used upon the wheel is contained in a box in the base of the machine, and a simple movement of the lever shown at the side of the machine brings the water up to the wheel, so that an abundance of it is carried up by the wheel itself without the use of pumps. A cock is provided by which the water may be drawn off when desired. Other than this no special features have been attempted in the construction of the machine, the object being simply to secure a plain, heavy machine, capable of giving the highest efficiency to the wheel. The apron is 14x30 inches, and the same machine is made with a base adapted to stand on the floor where desired. The builders are the National Car Seal Co., Hamilton, Ohio.



BENCH TOOL GRINDER.

Some time since we published a communication from Hardwicke & Ware, of Buffalo, in regard to locating a foundry on the top floor of the building. They are now located in a new five-story building, and in a recent communication they say: "We still keep our machine shop, blacksmith shop and brass foundry on the top floor, and have yet to find any one who can raise serious objections to it."

How some things go begging is illustrated by the fact that Professor Bell offered at one time to sell a half interest in his telephone for $10,000, but could find no buyer.

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CONTENTS.

PAGE.

Boiler Shell Drilling Machine 1
Improved Automatic Gear and Rack Cutting Machines 1, 2
The "American" System of Manufacture. By B. F. Spalding 2, 3
Odontics, or the Theory and Practice of the Teeth of Gears. By Geo. B. Grant 3, 4
A Boiler Making Firm Proposes to Insure Its Employes 4
Sketches of an Apprenticeship. By W. S. Rogers 4
On Contracts 4
A New Process for Generating and Cutting the Teeth of Spur Wheels. By Ambrose Swasey. 5
The Measurement of Power. By J. J. Flather. 6
Letters from Practical Men: A Fine Adjustment for Surface Gauge. By Walter Gribben—Handle Drilling Fixture. By Peter Shellenback—"For the Good of All." By Joel Oldone—Portland Cement for Setting Bed Plates. By H. J. B.—Contraction of Sulphur. By F. H. Treacy 6, 7
Portable Hydraulic Beam Punch 7
Bench Tool Grinder 7
Compound Locomotives 8
A Molder's Experience 8
Questions and Answers 8, 9
Manufactures 9, 10
Waste in Machine Shops. By Oberlin Smith 10, 11
A Scheme to Keep Nuts from Working Loose—Section Lines Across a Key. By Jarno 11
Machinists' Supplies and Iron 12

Compound Locomotives.

When the compound condensing engine first came to be used for mill purposes its use met with a good deal of opposition from engineers. There were not wanting those eminent in the profession who ridiculed the idea of expanding steam in two cylinders, when just as high grades of expansion could be had in one, and who did not hesitate to assert that there was no hope of gain in compounding. And while to-day there are but few who will deny the economy of compounding in such instances, there is positive disagreement as to why this increased economy results. In a general way the question of condensation is put forward, but the terms in which the statements upon which this theory is based are vague, and the demonstration is not satisfactory.

Fortunately for the establishment of the fact in relation to compounding, there existed in the instance of the steamship service of the world an incentive to steam engine economy that was far beyond and outside the mere cost of fuel, and it was in this service that the question was completely settled.

So much for the compound condensing engine. When it was generally acknowledged that such an engine could be operated with a degree of economy not attainable with a simple cylinder engine, the idea that a non-condensing compound engine would show superior economy was sure to follow, and while this opinion has not taken root very rapidly in this country, in Europe many such small engines are in use, with just what degree of economy it is hard to say. There is much difference of opinion on this point.

Just as the exigencies of steam navigation settled the merits of the compound condensing engine, it looks as if the demands of the railway service of the world would settle the question of economy in relation to the non-condensing compound. Several compound locomotives are now in use in this country, and there is great diversity of opinion as to their merits. A saving all the way from five to thirty per cent. is claimed for them. Their merits have yet to be established in every particular; a task by no means so simple as it appears.

Tests of locomotives are extremely difficult to make, as every one who has essayed the task will admit without question; still it ought to be possible to make comparative tests that should be reasonably satisfactory. Tests of any other kind meet with little favor; the actual coal per horse-power required in good locomotive practice is exceedingly problematical. Some years since, quite extensive tests of (non-compound) locomotives were made in England, showing a consumption of only two and one-half pounds of coal per horse-power per hour. We do not think, however, that any one seriously believes this result, in general practice, was ever attained, however honestly the tests may have been made, nor do we believe that a saving of thirty per cent. has or can be made by the use of a compound locomotive, all things being equal.

But it is not necessary to show a saving of thirty per cent. There are long stretches of road in the United States where coal is exceedingly expensive, and where a saving of ten per cent. would be very important; such a saving is important anywhere.

There are circumstances likely to favor the compound locomotive in a test against the simple cylinder engine. The strains ought to be better distributed in the compound, and the steam distribution ought to be better. Then if a saving is made in the engine it will have a double effect; the locomotive boiler is enormously overworked, and a saving in the use of steam in the cylinders will bring about greater efficiency of the boiler.

Then if it shall be practicable to use higher steam pressure with the compound there should be a saving due to this; for it is a fact well known to engineers that in most instances economy comes directly from the use of higher steam pressure. Generally the compound engine, so far as tests have been made, uses twenty per cent. higher steam pressure, which makes the test unfair for the simple engine, because the limit of economical pressure for the simple engine has not been reached.

Altogether the trials of compound locomotives that are now going on in this country are of great interest to engineers, and much good is likely to come from them. They will be watched with increasing interest.

A Molder's Experience.

Some years ago, in an English engineering establishment, some castings were called for that would be much heavier than ever made before, and for this and other reasons as well, much more difficult to make. The questions of methods and appliances for doing the work were being discussed among the various heads of departments and the proprietors, as is usual in such cases, and a young molder employed in the foundry happened to hear a conversation between the foundry foreman and a young man who was employed there as a mechanical engineer, regarding the strength that would be necessary in the mold to withstand the pressure of the molten iron. The engineer was saying, "Now you must bear in mind that the pressure at the bottom of this mold will be 140 pounds per square inch; we must arrange things to withstand that pressure safely, and the mold must, therefore, be very strong."

This gave our young molder something to think about, and the result of this thinking was that at the first opportunity he asked the engineer how he could tell what the pressure would be at the bottom of that mold.

The subject was explained as well as possible, and at the same time the advice given to study the subject of hydrostatics in any natural philosophy.

Reflecting on the subject, the young molder recalled that, so far as his experience went, any work done in foundries which was outside of the regular line—something that required study and the application of general laws of mechanics for its successful accomplishment—was always directed by some one who was not a molder, but who was familiar with the science of mechanics, and sufficiently acquainted with shop practice to correctly apply his knowledge of it.

This, as we have said, was years ago, and things have changed since then. Our friend did study hydrostatics, and seeing what a clear idea the knowledge of the subject gave him regarding some of the things connected with his business, which before had puzzled him greatly, he went on and studied other things, and as a result is to-day recognized as an authority on foundry matters, and holds a position of responsibility, for which he is paid far more than any molder can ever hope to earn by merely making castings in the way that he has been taught to make them.

We relate this incident not because there is anything especially remarkable about it, but because it is a good illustration of the course which must be pursued by every mechanic who wishes to do anything above the ordinary, and get paid for it above the ordinary mechanic's wages.

No mechanic should be satisfied to merely follow the lines laid down for him by others, at least not until he has done all that is possible for him to do in the way of getting an understanding of the principles underlying his trade. The machinist who goes on year after year erecting machinery without knowing just why gears of a certain size and pitch are placed here, and a shaft of a certain diameter there, satisfied to go according to the directions of some one who may not be a practical machinist at all, is, to say the least of it, easily satisfied, and moreover he may as wel make up his mind to be satisfied all his life with a position in which he will be led by others who will do his thinking for him.

For any one who has a reasonable amount of natural aptitude for the business, the point is soon reached at which he can go no further in mere manual skill. It takes but a short time, comparatively, for a man to become as good a lathe or planer hand, or as good a workman on the floor as he can ever become, so long as he does not study or try to do anything requiring more than mere manual skill. But when study begins, and the science of mechanics is reasonably well understood, there is then no limit to what may be attained.

There are men who do attain a moderate degree of success without the systematic study which we recommend, but this fact in no way disproves the importance of such study, any more than that a man should seek to put obstacles in his own path because others succeed in spite of similar obstacles.

A machinist works with or builds a machine having gears of a certain diameter and pitch, and he knows that these gears work well and do what is required of them. Now let him ask himself what he would do if twice as much work were required to be done by the gears. Would he increase their speed? if so, why? and would it be safe to increase speed sufficiently to do the work? or would the diameter and pitch be increased? if so, in what proportions, and why? A connecting rod at present used on the machine does its work all right; but now the rate at which it moves is to be doubled. Must its form or size be altered? and if so, what must the new dimensions be? Such questions as these and others that could be stated, the machinist should not rest satisfied until he is able to answer. Such questions are constantly arising in machine shops, and some one must be qualified to answer them, and when he is qualified he will usually be paid for doing it. Do not rest satisfied until you have at least made an honest effort to qualify yourself to solve any problem that may arise in connection with your business or trade, whatever it may be. Don't be satisfied to let others do the thinking for you until you have, by trial, proven that you are incapable of doing it for yourself.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

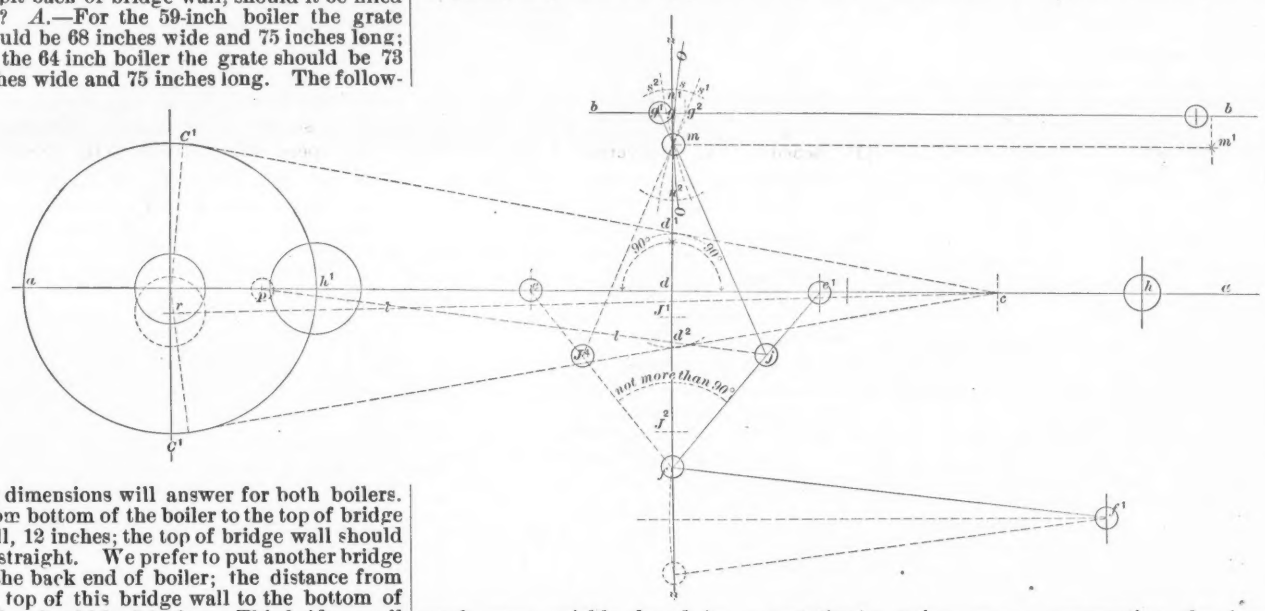
(430) D. E. P., Allegheny City, Pa., writes: Please tell me what is required of a millwright. Some say his only duty is the repairing the machinery; others say that he has to do a carpenter's work. *A.*—The duty of a millwright is not only to repair machinery, but also to build and set up new machinery. He must be a thorough machinist, and have a knowledge of woodwork, pattern making, and a knowledge of drawing. In short, he must be a thorough mechanic, capable of doing any kind of work in the machinery line.

(431) W. H. W., Petaluma, Cal., writes: There has been an argument in my shop in regard to a hydraulic wine press. A. says that a hydraulic press with a ram 24 inches diameter, pump plunger 1¾ inch diameter, 6 inches stroke, and with a basket 5 feet diameter, will press harder with 100 pounds per square inch on the ram than one with a ram 12 inches diameter, and with the same pressure per square inch, the pump and basket remaining the same as before. B. says there will be no difference. They have agreed to refer this question to you for a decision. *A.*—If we understand your question correctly, it is simply this: There are two hydraulic presses; they are exactly alike, with the exception of the ram; in one press the ram is 24 inches diameter, in the other it is 12 inches diameter; the power applied to the pump is the same in both cases. The question is: Which press will exert the greatest pressure? Since the pressure per square inch on each ram is the same, we may throw the pump plungers, and the forces applied to them, out of the question. Under these conditions, the total pressure exerted by each ram will be as their areas. The 24-inch ram has an area of 452.39 square inches, and the 12-inch ram has an area of 113.098 square inches, hence the pressure exerted by the 24-inch ram will be $\frac{452.39}{113.098} = 4$ times as great as the pressure on the plunger. If the rams are allowed to lift a weight, then the work done by each ram is numerically equal to the product of the weight into the distance through which it is moved. In the

case before us, the small ram will move four times as fast as the larger one, consequently the small ram is capable of performing as much work as the large one.

(432) R. C., Hamilton, ——, writes: There are two boilers set side by side. One of these boilers is 59 inches diameter, 11 feet 10 inches long; it has 70 tubes 3 inches diameter. The other boiler is 64 inches diameter, 12 feet long, with 84 tubes 3 inches diameter. They are built in brick work. Fuel, hard and soft coal. In order to obtain the best results, what should be the length and breadth of grates, distance between bottom of boiler and top of bridge wall, depth of combustion chamber, distance from top of grate to bottom of ash pit? What is the best shape of pit back of bridge wall, should it be filled up? *A.*—For the 59-inch boiler the grate should be 68 inches wide and 75 inches long; for the 64 inch boiler the grate should be 73 inches wide and 75 inches long. The following dimensions will answer for both boilers. From bottom of the boiler to the top of bridge wall, 12 inches; the top of bridge wall should be straight. We prefer to put another bridge at the back end of boiler; the distance from the top of this bridge wall to the bottom of boiler should be 5 inches. This bridge wall will divide the combustion chamber into two chambers; the bottom of both chambers should be horizontal; the distance from the bottom of these chambers to the bottom of the boiler should be 56 inches; the height of the back combustion chamber should extend to the top of flues. The distance from bottom of boiler to the top of grate bars should be 32 inches; from top of grate bars to bottom of ash pit, 24 inches. 2. What should be the area of the flues leading to the chimney? *A.*—For the 64-inch boiler the flue area should be 500 square inches, and for the 59-inch boiler it should be 400 square inches. 3. Is an air blast as good as a steam blower? *A.*—We prefer the air blast to the steam blower. 4. Should we have a damper? *A.*—You should have a damper in each flue leading to the chimney.

(433) E. G. T., Detroit, Mich., writes: Please give the method of laying out the Joy valve gear. *A.*—Lay down the center line *a a* of the cylinder, and that of the valve spindle *b b*, at the relative distances required for the engine to which the application is to be made, the valve spindle center line being, however, in the plane of the vibration of the connecting rod. Draw the path of the crank-pin, and the center lines of the connecting rod $c\ c^1\ c^1$ for both upper and lower positions when the piston is at half stroke. Take a point *d* on the center line of the connecting rod, where its vibration between d^1 and d^2 is equal to about double the length of the full stroke of the valve (it is better to allow rather more than less). It may, however, be chosen very much to suit the other arrangements of the engine, such as the position of the slide bars, brackets, etc., getting, however, if possible, a vibration of the connecting rod fully equal to double the stroke of the valve, to avoid too great an angle of the slide link when put over for full forward or backward gear. Having chosen the point *d*, draw a vertical line *z z* through it and at right angles to *a a*; and mark off the two points *e*, *e* on each side, these being the extreme positions of the point *d* on the connecting rod for front and back stroke; from these points draw lines to a point *f* on the vertical, so far down that the angle between them shall not be more than 90°, less is better, if there is room to allow of it (these will represent the center lines of the first link pinned to the connecting rod). The point *f*, which will rise and fall with the vibration of the connecting rod, is to be controlled as nearly as may be on the vertical line by a link pinned either forward near the cylinder at f^1, or, if more convenient, it can be pinned backward. Next, on the valve spindle center line *b b*, mark off on each side of the vertical *z z* the amount required for lap and lead together, at g-g^1 and $g\ g^2$; g-g^1 being "lap" and "lead" for the front end of the cylinder; and g-g^2 being "lap" and "lead" for the back end of the cylinder. Then, assuming the piston to be at the front of the cylinder, and the centers of the connecting rod to be at $h\ h^1$ (*h* being the crank-pin), the point *d*, which we have chosen to take motion from will be at e^1, and the link pinned to the connecting rod for transmitting motion to the valve will be at $e^1\ f$. From a point on this link, which has at first to be assumed, say at *j* (which will be about one-third more than the half vibration of the connecting rod, that is, d^1 to *d*), draw the center line of the lever actuating the valve, that is, joining *j* and g^1; the point where this line crosses the vertical *z z* will be the center or fulcrum of the lever, and will also be the center of oscillation of the curved links in which the blocks carrying the center of the lever slide; this center is marked *m*. The function of the link e^1-*f*, and the attachment of the valve lever to it at *j*, is to eliminate the error in vibration of the lever, center *m*, which would otherwise arise from the arc passed through by the lower end of that lever. Although the position of the point *j* may be found by calculation, it is much more quickly found by a tentative process, and to test if the assumed point *j* be the correct one, we mark off on each side of *m*, vertically, the correct vibration required, $n^1\ n^2$, which will be the same as the vibration of the connecting rod on the vertical line, *z z*. Then apply the distance e^1—*j* to d^1—j^1 and $d^2\ j^2$. Then, if the length *j m* be applied to $j^1\ n^1$ (measuring from j^1) and to $j^2\ n^2$ (measuring from j^2) and the point *m* fall below $n^1\ n^2$ in each case, it will be necessary to take a point on $e^1\ f$ higher than *j*; or if, on the other hand, *m* falls above $n^1\ n^2$, then a point must be taken on $e^1\ f$ lower than *j*. This point will generally be found on a second trial. The point *m*, as said, now represents the center of oscillation for the links, and the center or fulcrum of the lever. And these must coincide, when the piston is at each end of the stroke, the lead being then fixed; and the links can be pulled over from forward to backward or any point of expansion without altering the lead. This may be taken as a test of the gear being set out correctly. The point *g* will be the point of attachment for the valve spindle link, which may be made any convenient length, but from that length as a radius the curve of the links must be drawn from a center m_1 on the parallel line m—m^1; the angle at which this curve is set from the vertical (which is mid-gear) will give forward or backward gear—the angle leaning forward s^1, or to the front of the engine, being forward gear, and the reverse s^2 being backward gear. The amount of the angle, marked on the curve of extreme vibration at s-s^1 or s-s^2, will be equal to one-quarter more than the full opening of the port at that angle (that is, if 1″ opening of port is required, then the amount of angle *s* to s^1 must be 1¼″), and the point of cut-off will be about 75 per cent. Laid out in this form the "leads" and "cut-offs" for both ends of the cylinder, and for backward and forward going, will be practically perfect and equal, and the opening of ports also as near as possible equal. If a longer "cut-off" than 75 per cent. is required, it is only necessary to increase the angle of the curve *o o* beyond s^1 for forward gear or beyond s^2 for backward gear. It will be noticed that in this gear the "lap" and "lead" are entirely dependent on the action of the lever *j*, *m*, *g*, as a lever, and may be varied according to the length of *m g*. And the opening of the port (beyond the amount given as lead) is dependent on the amount of angle imparted to the curved link *o o*, and will be, as above said, about four-fifths of the amount of that angle from the vertical, measured on the line of extreme vibration. Deviations from the above positions and proportions may be made without materially altering the correctness of the results. Thus, if it is found necessary to raise or lower the center *m*, to clear wheels, frames, or other gear, this may be done till the angle of $m\ m^1$ is out of the parallel of the cylinder center line up or down by one in thirteen (1 in 13); it is not well to go beyond this, but the lines $m\ m^1$ and $b\ b$ will be parallel, and the position of the curve $o\ o$ for mid-gear will be at right angles to $m\ m^1$. Again, the point e^1 may be taken either above or below the center line of the connecting rod, if it be wished to avoid piercing the rod, the pin at e^1 being carried in a small bush or block attached above or below the connecting rod. Again, for locomotives, if the wheels are so small that the link $e^1\ f$ would come too low, it may be cut short at the point *j*, and this point connected by a link $l\ l$ to a small return crank *p* on the crank-pin, the movement of the counter-crank being equal to that from *j* to j^4. The diagram is drawn for an engine where the center of crank axle is on the center line of the cylinder, but if this be below, as is usual in American locomotives, then the base line on which to construct the diagram of the valve gear itself will be the average center line assumed by the connecting rod for such lowering of the crank axle center, drawn from *c*, the middle position to a point, say *r*, representing the lowered center of the axle. The vertical *z z* will be at right angles to this new base line *c r*, all the other processes following. Or, for marine engines, this link $l\ l$ may be connected to a point on the air pump lever where its stroke is equal to $j\ j^4$. For vertical engines the same rules apply, by placing the diagram vertically and altering relatively the terms "vertical" and "horizontal." While the proportions shown on the diagram give the best average results, these proportions may be varied within very wide limits, according to the requirements of the design of the engine. Thus, when the distance between the center of the cylinder and center of valve spindle is small, as with a small cylinder and a long stroke, the link $e^1\ f$ may be considerably lengthened; the point *j* will thus be dropped, and convenient angles for all the links, etc., will be maintained, the room for the various movements being got below the center line of the cylinder, when it cannot be had above. The reverse proportioning of the parts being made when the conditions are reversed, as with a large diameter of cylinder and a short stroke. 2. From whom can I obtain the reports of the navy for 1889 and 1890? *A.*—Write to the Secretary of the Navy, Washington, D.C.



BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Friday morning for the ensuing week's issue.

Lexington Cut Iron Gears. See adv. on p. 20.

Link-Belting and Sprocket Wheels.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Engineering Co., Philadelphia and N.Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

"The Bulldozer," a new departure; forging by pressure. M'f'd by Williams, White & Co., Moline, Ill.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 8 Spruce St., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

Ice and Refrigerating Machines, 155 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

"How to Keep Boilers Clean." A 96-page book, mailed free by Jas. E. Hotchkiss, 120 Liberty st., N.Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Milling Machines. Pedrick & Ayer, Philadelphia, Pa.

Universal Grinding Machine. Pedrick & Ayer, Philadelphia, Pa.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

Audubon Machine Works, New Haven, Conn. Special machinery, heavy and light.

Emery in 10 lb. tins (for machinists' use) a specialty. The Tanite Co., Stroudsburg, Pa.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See Oct. 9, p. 15. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

For the Latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Send $1 for Catalogue D, Fine Tools and Supplies. Over 550 pages. Fully illust'd. Free when $10 worth goods are ordered. Frasse & Co., 92 Park Row, N.Y.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal st., Chicago, Western Agent.

For best Return Steam Traps, Pressure Regulators Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st., N.Y. Send for des'n.

"Roper's Hand-Books," for engineers and firemen. Send for descriptive catalogue. Address Edward Meeks, publisher, Philadelphia, Pa.

Billings & Spencer Co.'s Packer & Boiler Ratchet, & all kinds of Forged Wrenches. S. A. Smith, 23 S. Canal st., Chicago, Western representative.

25″ 32″ 37″ 42″ "Only Drill Press built on 'Ko-rekt' principles, even if they come from Jersey." Gould & Eberhardt, New Ark, N. J.

Patent Attorney R. G. DuBois, 715 11th street, Washington, D. C., procures 1st-class patents for inventors. Send for pamphlet. Guaranteed by Rand, McNally & Co., of Chicago.

Every pattern maker and wood worker should have a Dutton's clipper grinder, No. 5. Send for circular to Montgomery & Co., 105 Fulton street, New York City.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations, 8vo. cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting Rods for small connections. Especially adapted for Valve Rod for Steam Engines. T. C. Dill Machine Co., Philadelphia, Pa.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

MANUFACTURES

A cotton-gin and grist-mill will be erected at Sardis, Texas.

A. C. Jones, Hot Springs, Ark., will erect a $35,000 ice factory.

The establishment of an ice factory at Lakeland, Fla., is talked of.

The erection of a $500,000 cotton-mill is talked of at Yazoo City, Miss.

The establishment of a car works plant is talked of at Lynchburg, Va.

The erection of an electric light plant is contemplated at Darien, Ga.

An agricultural implement factory will be erected at Cordele, Ga.

Ground has been broken for new malleable iron works at Toledo, Ohio.

W. H. Withgott is erecting a new iron and brass foundry at Easton, Md.

The Moline Plow Company, at Moline, Ill., is putting up a large addition.

The Nashua Iron and Brass Foundry, at Nashua, N. H., is increasing capacity.

An electric light plant will, it is reported, be erected at Gainesville, Texas.

A stock company is being organized to erect a roller flour-mill in Belton, Tex.

It is stated that a Canada steel manufacturer will remove his plant to Atlanta, Ga.

Blaine Bros. are reported as enlarging their car shops at Green Cove Springs, Fla.

The Eufaula Cotton-mills will double the capacity of its cotton-mill at Eufaula, Ala.

The Batesville Iron Works, Batesville, Ala., will add a foundry to its machine shops.

The Emerson Machine Company, of Granby, Conn., are to double their capacity.

An Ohio party has made a proposition to establish a nail-mill in Morristown, Tenn.

The Kingsbury Manufacturing Company is erecting a machine shop at Beresford, Fla.

Liddell & Co. are about to build a large machine shop and foundry at Charlotte, S. C.

Ground has been broken for the Sheffield (Ala.) Foundry, Machine and Boiler Works.

A stock company is reported as organized to erect an ice factory at Atlanta, Texas.

The Alabama Pipe Company has commenced the erection of pipe works at Bessemer, Ala.

J. W. Garratt & Co., of St. Louis, Mo., are contemplating an addition to their foundry.

J. H. Gill, of Raleigh, N. C., will establish in Ivanhoe, Va., an iron foundry, machine shops and stove works.

The Great Northern Iron and Steel Co., capital $2,000,000, have filed articles of incorporation at Duluth, Minn.

The contract is reported to have been made for the erection of boiler and engine works at Max Meadows, Va.

A $300,000 stock company has been incorporated, as the Radford Pipe and Foundry Company, in Radford, Va.

The Vulcan Boiler Company has been organized at Findlay, Ohio, and will start business with a $35,000 capital.

W. A. Rinehart and others are organizing a stock company to erect a foundry and machine shop in Covington, Va.

D. W. Flickwir and others will build and operate an iron furnace in Riverton, Va. The capital stock will be $150,000.

Mr. Philbrick is negotiating with R. Mugge, of Tampa, for the removal of his electric light plant to Key West, Fla.

The De Bardeleben Coal and Iron Company will, it is stated, increase the capacity of its Oxmoor (Ala.) iron furnace.

The Riverton Land Co. will, it is stated, soon commence work on the erection of two iron furnaces at Riverton, Ala.

The Blacksburg Machine and Iron Works has been incorporated in Blacksburg, S. C., with a capital stock of $12,000.

The Youngstown Iron and Steel Company, of Youngstown, Ohio, has been incorporated, with a capital stock of $600,000.

Machine shops that are to cost $1,000,000 are to be erected at Fort Worth, Tex., by the Union Pacific Railway Company.

The Chicago Machine Works, an establishment which will employ 500 men when completed, will be erected in Sioux Falls, Dak.

The Estillville (Va.) Planing-mill Company will put in new machinery for the manufacture of sash, doors, blinds and furniture.

A Houston company is reported as having made a proposition to erect an electric light plant and an ice factory in Seymour, Tex.

The Smithville Iron Co. has been organized by J. P. Gay and others to build one or more iron furnaces at Lawrenceburg, Tenn.

The new repair shop for the Pullman Palace Car Company at Pullman will be 500x500 feet, two stories high, and will cost $250,000.

The Georgia Stove and Range Co., located at Atlanta, Ga., has recently increased the capacity of its works and enlarged its foundry.

A $50,000 stock company has, it is reported, been organized at Huntsville, Ala., by New York parties, for the purpose of erecting a pulp-mill.

It is reported from Huntington, W. Va., that an Eastern syndicate has an option on the Ensign Car Works, and is preparing to take control.

An ice factory, with a capacity of ten tons a day, will be built at Alexandria, La., before next summer. A suitable site has been purchased.

The New York Lead and Zinc Company has been incorporated at Kansas City, Mo, with an authorized capital stock of $100,000, all paid in.

The Cummings Iron Works, at Hammond, Ind., have been purchased by a syndicate, who, it is said, will increase the plant and employ 500 hands.

The people of Sioux Falls, S. D., have been asked to give $50,000 and the necessary land toward the establishment of an edge-tool manufactory there.

Boston (Mass.) parties will, it is reported, organize the Beaumont Car Works, with a capital stock of $500,000, and erect car works in Beaumont, Tex.

The J. N. Sarborough Manufacturing Co., of Americus, Ga., will be organized with a capital stock of $100,000, to manufacture automatic car brakes.

Steps are being taken to organize a stock company for the purpose of erecting a $500,000 cotton-mill in Austin, Tex. A. P. Wooldridge is interested.

Negotiations are pending for the establishment of a nail-mill, a rolling-mill, and a muck-bar-mill, with twenty-eight puddling furnaces, at Buena Vista, Va.

The Cincinnati Milling Company has accepted a proposition to locate at Sidney, O. The firm manufactures machinery, and employs forty-five skilled workmen.

The Herzog Manufacturing Co., of Minneapolis, Minn., will erect a two-story brick forge and machine shop, and a one-story foundry, at a total cost of $45,000.

In a recent item mentioning improvements being made by the Dickson Car Wheel Co., Houston, Texas, the types made us give the name Dixon, which is wrong.

The Sandy Hill (N. Y.) Iron and Brass Works have the foundations laid, and have commenced on the brick work of their new building, which will be 50x160 feet.

It is said that Messrs. Cartwright, McCurdy & Co. are to construct, at a cost of $50,000, a puddle-mill adjacent to their Enterprise Iron Works plant, Youngstown, Ohio.

The San Antonio & Aransas Pass Railway Company (office, San Antonio,) is reported as having secured site, and is to erect machine and repair shops in Waco, Tex.

The Phœnix Iron Works, Cleveland, Ohio, are compelled to extend their capacity. They will, in a few days, determine on location, and proceed to erect extensive works.

The Ajax Rustless Torpedo-proof Pile Armor Co., has been incorporated at San Francisco, Cal.; capital stock, $1,000,000; incorporators, D. S. Dorn, R. J. Davis, R. H. McDonald.

It is officially stated that a large car wheel works will be built at Roanoke, Va., as well as a number of other industries established, that will employ several thousand hands.

Gardner & Warring will enlarge their knitting mill, at Amsterdam, N. Y., and when the addition is completed will employ double the number of persons employed at present.

The new electrical company has been organized at Pittsfield, Mass., as the Stanley Electric Manufacturing Company, and a charter will be obtained at once. The capital is $25,000.

Arrangements are reported nearly completed for the erection, at a cost of $100,000, of a brass and copper rolling-mill in Chicago, Ill., located at Fullerton and Crawford avenues.

The Henderson Steel and Manufacturing Co., at Birmingham, Ala., has increased its capital to $100,000, will enlarge its works and erect two ten-ton iron furnaces and blooming train.

The Navy Department has decided to award the contract for furnishing the forgings for the batteries of the new battle ships to the Bethlehem Iron Company, of Bethlehem, Pa.

The Folding Sewing Machine Company has been incorporated at Springfield, Ill, with a capital stock of $50,000. The incorporators are Marion O. Smith, Frank S. Smith, A. C. Smith.

The Ryan McDonald Manufacturing Company, of Waterloo, N. Y., will, it is stated, remove its machine works to Baltimore, Md., and organize a stock company to operate the same.

E. S. Read, W. W. Hill, F. N. Read, and others, have incorporated the Eureka Safe and Lock Co., for the manufacture of safes and locks, at Covington, Ky. The capital stock is $50,000.

The iron foundry and plow works of the C. P. McWane Plow and Foundry Co. have been purchased by the Graham Land and Improvement Co., and will be removed to Graham, Tex.

Detrick & Harvey Machine Works, Baltimore, Md., have recently put in a new "Putnam" engine, and have started work on the extension to works, which will give needed additional facilities.

J. H. Fisher, W. A. Wilmot and J. H. Callahan, of Chicago, have incorporated the Fisher Movable Frog and Railway Company, for the manufacture of railway appliances; capital stock, $500,000.

Since the successful production of basic steel by the Southern Iron Co., of Chattanooga, Tenn., it is reported that they will put in a steel plant at Rockwood, Tenn., that will be the largest in the South.

The Madison Car Company has been incorporated at Madison, Ill., capital $500,000, to build and repair cars and railway equipment; incorporators, L. M. Ramsey, Charles F. Orthurin, William Bacon.

The contract for the steel plant at Ashland, Ky., has been awarded to Mackintosh, Hemphill & Co., of Pittsburgh. Work on the plant is to be commenced at once and completed in the summer of 1891.

The Elliott Frog and Switch Co. (East St Louis) has purchased two blocks of land in the Aimes tract, and it is said they will erect new and extensive works in the spring on the property in question.

The National Wheel Company was formed at Jackson, Mich., October 13, with $50,000 capital stock, $35,000 being paid in, to manufacture car wheels. The company will build a shop 60x200 feet.

Eastern capitalists were in the city of Youngstown, Ohio, looking for a site for the purpose of locating a plant for the manufacture of screwdrivers, wrenches, clothes wringers, etc., employing three hundred men.

The Terre Haute Shovel and Tool Co., capital stock $100,000, have been organized at Terre Haute, Ind. The object of the company is to manufacture and sell all varieties of agricultural and horticultural implements and tools.

The Minneapolis (Minn.) Threshing Machine Co. will begin the manufacture of steam engines as soon as the necessary addition to their works can be built. The new plant will cost about $30,000, and give employment to some 125 men.

The Cavener Railway Power Transmission and Brake Co., Chicago, has been incorporated, to manufacture railway appliances; capital, $200,000; incorporators, Alexander R. Cavener, Thomas R. Freeman and Harry C. Whitehead.

On the 27th inst., a license of incorporation was granted to the Smith & Cade Company, Chicago, to manufacture corrugated iron and sheet metal work; capital stock, $30,000; incorporators, John Smith, S. T. Cade and J. H. Perkinson.

The American Steel Post and Pole Co. (Chicago) is a new concern which has been formed to manufacture and sell steel and metal poles of all kinds; capital, $100,000; incorporators, Thomas J. Thorp, Thomas Bennett, William H. Herrick.

An organization has been formed at Cincinnati, O., to build pipe-works at Radford, Va., under the name of the Standard Pipe and Foundry Co. The amount of paid-in capital is placed at $300,000, and the work of construction will begin at once.

The Washington Mills, Lawrence, Mass., worsted manufacturers, will at once increase the plant to an extent that will give employment to 750 more operatives. New and improved machinery will be put in, and the production largely increased.

The Portsmouth Iron Machine Company, of Portsmouth, O., has signed contract for the erection of a branch boiler works and machine shop at Grand Rivers, Ky., to be known as the Moore Structural Iron Works, with a capital of $150,000.

The Cleveland (O.) Milling Company mills have been sold to James Osborne, of Glasgow, Scotland, proprietor of one of the largest milling businesses in Scotland, and one of the heaviest importers of American flour to be found in the United Kingdom.

The Hardwicke & Ware Manufacturing Company, engineers' and plumbers' supplies, Buffalo, N. Y., has succeeded Hardwicke & Ware. Customers are notified that the regular business will be continued in their new five-story building on Washington street.

The Columbia Steel Car Company has purchased a site for the erection of a plant for the manufacture of steel cars. It lies in the town of Maine, about 14 miles northwest of Chicago, Ill., and is located between the Northwestern and the Wisconsin Central Railroads.

The Toronto Rolling-mill and Forging Company, of Toronto, Can., has been incorporated, with a capital stock of $200,000, and will erect works at West Toronto Junction. It will take over the plant and business of the Toronto Drop Forge Company, whose works have heretofore been in Toronto.

A $100,000 stock company, to start a plumbers' supply factory, has been incorporated at Bessemer, Ala., as the Alabama Pipe Company, by F. H. West, of Bessemer; D. McK. Sinclair and A. F. Bridge, of Whitewater, Wis., and others. It proposes to manufacture soil pipe, plumbers' supplies and wrought-iron ware.

The East Buffalo Iron Works, of Messrs. Farrar, Trefts & Rood, which have practically become a railroad shop, devoting its facilities to railway work, is building an extension which will increase its capacity about 50 per cent. The new building will give the works a molding floor 460 feet long and 80 feet wide.—*Buffalo Express.*

The Steel Truss Car Wheel Company has completed works at Edwardsville, Ill., for the manufacture of a new car wheel, the invention of Jacob Dunstedler, which is composed of three parts only—the tire and two disks. The plant will be in operation by November 1. A. G. Lindemuth is secretary, and Gustav Cramer is vice-president, with office in St. Louis, Mo.

A Minneapolis dispatch says that about 3,000 acres of land, at a cost of $1,500,000, have been bought near the city limits, on three trunk railway lines. The land will be built up with manufactories and mechanics' houses, somewhat after the plan of Pullman, Illinois, only on a much larger scale. It is estimated $7,000,000 will be the cost of land and improvements.

The National Chemical Works, with a capital of $100,000, is negotiating with the city council at Macon, Ga., for fifteen acres of the city reserve, as a site for its extensive plant which the company propose to erect in that city. The plant will have a capacity of 25,000 tons of manufactured fertilizers and chemical products per annum, which will require the services of 150 to 300 workmen.

There is water-works agitation in Manchester, N. H.; Alliance, Neb.; Canton, S. D.; Quincy, Ill.; Sturges, S. D.; Martinsville, Va.; Seymour, Tex.; Hebron, Neb.; Menasha, Wis.; Aberdeen, Wash.; Cisco, Tex.; San Angelo, Tex.; Centralia, Wash.; Jamesville, Mass.; Benton Harbor, Mich.; Bay City, Mich.; Cranford, N. J.; Key West, Fla.; Dayton, Ohio; Belleville, Ill.; San Jose, Cal; Zanesville, Ohio.

At the new town of Savernake, Va., it is reported that the following industries will be established: Tin plate works with capacity for 3,500 boxes IC tin plate weekly, ferro-manganese furnace, 80-ton iron furnace, iron foundry and machine shop, coke plant and open hearth steel plant with plate and galvanizing mill, and negotiations are said to be pending for iron bridge works, lock factory, hardware factory, and malleable iron works.

The A. Plamondon Manufacturing Company has purchased 10½ acres in the western part of Chicago, Ill., on which it proposes to erect works for the manufacture of pulleys, shafting, etc. The company has been too cramped in its present quarters, and has decided to enlarge. Plans for the necessary improvements include a three-story building, and also a two-story building, or series of buildings, will cover the larger part of the property.

Work on the foundation for the new Bennett yarn-mill, New Bedford, Mass., will be begun immediately. The structure will be somewhat larger than the corporation mill now running, which contains 30,000 spindles. The new mill will contain 50,000 spindles, and will manufacture a high grade of yarns which the new tariff bill restricts from importation. Brickwork will not begin till spring, but it is expected to have the mill ready for machinery by July 1, 1891. The total capital stock of the company, with the recent increase of $400,000, amounts to $700,000.

The Valley Machine Co., Saginaw, E. S., Mich., makes the following announcement: We are pleased to announce the purchase of the machine shop and foundry plant formerly operated by the Newton Machine Company, and are prepared to execute, in the best manner possible, all classes of work pertaining to the business. Our equipment is entirely new throughout, and includes the most modern machine tools. In the foundry department we are prepared to furnish heavy and light iron and brass castings of superior quality, and promptly. We manufacture pulleys, couplings, hangers, pillow blocks, angle boxes, flat boxes, gearing, fire-fronts, grates, lumber trucks and special machinery. We are dealers in engines, boilers, steam pumps, feed-water heaters, injectors, governors, lubricators, brass goods, shafting, link belting, etc.

The Jenkins Electric Milling Machine Company has been incorporated at Pueblo, Col., by J. B. Orman, C. L. Wall, J. N. Carlile, Chas. Henkel, Fred Rohrer, A. Pollard, F. W. Gill, J. A. Thatcher, W. W. Strait, A. Sloan, J. J. Stanchfield and W. P. Hobson. The object of the company is to acquire, by purchase, the letters patent granted by the United States, England, France, Belgium, Germany, Austria and Canada to William H. Jenkins for his invention of an improvement in mining drills; to erect, own and operate by electricity, steam or water power, any and all kinds of mining machinery; to erect, own and operate electric light and power stations; to prospect for, locate and operate mines, and to buy and sell the same; to construct and operate railroads. The capital stock is fixed at $100,000, and Pueblo is designated as the principal office of the company.

Immense new shops are being built at Buffalo, N. Y., for the Lake Erie Engineering Works. The plans provide for a machine shop, built on the gallery plan, to be 250 feet wide and 112 feet deep. From the floor to the tracks of the traveling crane will be 40 feet in the clear, and from the floor to the bottom of the iron truss will be 60 feet in the clear. The foundry will be 230 feet wide and 112 feet deep, the distance from the floor to the track of the traveling crane being 30 feet, and from the floor to the under side of the iron girders 45 feet. In the machine shop two 30-ton traveling cranes will be used, and in the foundry two 30-ton and two 6-ton traveling cranes will be used, all being operated by electricity. The machine shop is to be enclosed about December 1st, and the foundry about January 1st, both shops to be ready for business by April 1st, when 500 hands will be given steady employment. The buildings alone will cost $110,000, exclusive of the ground, and with machinery complete will cost $300,000.

Waste in Machine Shops.*

BY OBERLIN SMITH.

There are in machine shops, as in all industrial establishments, many kinds and degrees of waste, but I do not propose herein to dwell at length upon the minor wastes which are constantly occurring, such as careless damaging of buildings and tools, wasting of oil and other supplies, loafing, gossiping, etc.; for all these things, although in a measure preventable, and to be prevented as far as possible, are small in degree compared with the great and needless waste which is almost constantly going on, in the majority of our shops, in the matter of improper *speeds* and *feeds*.

To reform this evil is one of the most difficult matters among the functions of a shop superintendent, but constant watchfulness and systematic methods will go a long way toward increasing, by a big percentage, the amount of work that can be done in a machine tool—especially as regards lathes, planers, slotters and shapers.

To get the speeds high enough with such tools as lathes, drill presses, milling machines, etc., where the diameter of the work or of the cutting tool is variable, an excellent plan is to put up a card of instructions, in tabular form, upon the various machines, stating which of the eight or ten speeds usually available should be used for given materials and for given diameters of work or of cutters. The different speeds given by the various steps of the cone pulleys, and by the adjustment of the back gearing, should, of course, be lettered or numbered for convenient reference.

In the case of shapers and slotters, the material and the length of stroke only need be mentioned as a basis upon which to determine speed, while with planers, if provided with more than one speed, the material alone would have to be regarded.

* Presented at the Indianapolis meeting of the American Association for the Advancement of Science.

The matter of depth and width of cut is one that must be left in a great measure to the judgment of the workman, unless he is doing a lot of duplicate work, where experiments can be made and instructions written in advance that will give the most economical size of chip. In general, workmen should be trained to carry out the following rule, unless there is some good reason for making an exception.

Rule.—Upon all work which is strong enough not to be broken, bent or injuriously sprung out of shape thereby, take the rough cut or cuts as heavy as the belt of the machine, when in proper condition, will drive. If practicable, take the first cut deep enough so that only a sufficient amount of surplus metal for the finishing cut will be left. After deciding this depth make the cut as wide, by means of the feed, as will meet the first-named requirement of the heaviest practicable chip. On finishing cuts take as wide a feed as is possible without undue "chatter," for two reasons—to get done more quickly, and to wear the tool less, by passing it over a shorter distance of peripheral travel.

Of course if the work is light and flexible, without there being a chance to support it properly, the above rule must be very much modified to suit the particular existing conditions. It will, in many cases, be found difficult to get the coarse feed desirable with conventional lathes. These should be altered so as to feed as fast as, say, up to four per inch; and this should be available by a quick movement of the hand, without having to shift the "change gears."

Another evil, which can be remedied only by constant training and watching, is setting the stroke of planer beds, slotter rams, and shaper rams *too long* for the particular piece of work in hand, thereby wasting the valuable time of the machine by letting the tool "over-run" far more than is necessary at one or both ends of stroke.

I have made no calculation as to the average percentage of loss due to the evils above specified, but have no doubt that in our ordinary shops, where the work has not been carefully systematized, the waste will run all the way from 10 to 30 per cent.

A Scheme to Keep Nuts from Working Loose—Section Lines Across a Key.

BY JARNO.

As Mr. Norton was looking at a piece of work in the planer, a nut dropped off a reciprocating shaft and struck his foot, which attracted his attention to the nut and distracted from the work. Now, the purpose of this nut was to hold a gear on the shaft, but, as it could not even hold itself on, it might as well have been put next the shoulder, with the gear outside, and let the gear do the holding.

Norton relates: "Years ago, I had experience that taught me never to expect a nut to stay on when it is screwed up against a hub on a reciprocating shaft, as in Fig. 1. When the reciprocating motion is as quick as those in a planer, and the hub and shaft are not a forced fit, most keys will work loose and allow a slight slipping of the hub, in a rotary direction, at each reversing, which the nut has little power to prevent. Then the friction against the hub tends to turn the nut, which screws back more easily than up, so that, however slight the slipping of the hub, a thousandth inch or less, the nut works back, and, unless fitted tight, it comes off.

"The most that we can expect of the nut is to keep the hub from slipping endwise. A good scheme for this is to have the bearing *A*, Fig. 2, a little longer than the hub, and screw the nut up hard against only the shoulder at *B*. The friction against *B* gives the nut a tendency to stay on, which it does not have in Fig. 1.

"Even this scheme is not safe in machinery subjected to heavy jar, and where a failure is disastrous. In locomotives, the use of split pins through screws, just outside the nuts, is becoming more general."

The planer man has compromised with Fig. 1 by winding waste around the thread, and then screwing the nut on hard. In the same planer a nut holds a crank bushing on the cross-feed screw, because the end of the screw has been rivet-headed.

There is still a difference of opinion as to whether it is better to section line just down to a full key line, as in Fig. 1, or carry a false section across the key down to the shaft, as in Fig. 2. I prefer Fig. 2.

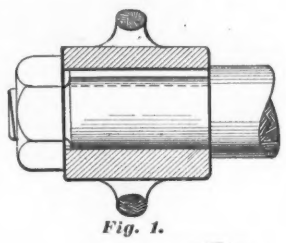


Fig. 1.

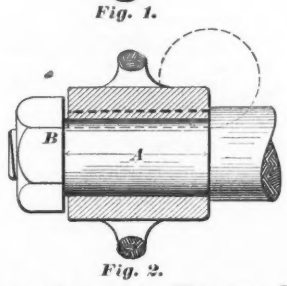


Fig. 2.

TO KEEP NUTS FROM WORKING LOOSE.

Shafting makers cut keyways longer than the keys, and leave the curvature of the cutter at the ends, as shown by the dotted circle in Fig. 2. The use of such a keyway might be profitably extended, because it is so expensive to have a square corner at the end with a key fitting into it, as in Fig. 1.

Construction of Bells.

Locomotive designers are often called upon to design a bell, and since the method of designing a bell of this kind is also applicable to the construction of all ordinary bells, an explanation of this method may interest many of our readers. The size of the bell is generally designated by the diameter of the mouth of the bell; if it is 12 or 18 inches in diameter, the bell is said to be a 12 or 18-inch bell. After this diameter has been established, the other dimensions of the bell, excepting its shank, by which the bell is fastened to yoke, are derived from this diameter. For large locomotives 18 or 19-inch bells are generally used, and for the smaller engines 13-inch bells seem to be the favorite ones. For designing a bell of any size, the following method may be adopted, and satisfactory results expected.

Draw the diameter $f\ a$ of the mouth of the bell, also draw the center line $C\ C$ perpendicular to $f\ a$. Divide the diameter $f\ a$ into 10 equal parts; each part is called a stroke; this diameter, divided into strokes, forms a scale from which the other dimensions of the bell are laid off. Hence, for the sake of convenience, draw a line $f\ a$ equal in length to the diameter of the mouth of the bell on a separate piece of paper, which is to serve as a scale, divide $f\ a$ into 10 equal parts, and again divide one of the end divisions into 10 equal parts, and thus complete the scale. Since one of these parts (a stroke) is divided into 10 equal parts, we have constructed a decimal scale.

Parallel to the center line $C\ C$ draw a line b; the distance between b and $C\ C$ must be equal to $2\frac{1}{2}$ strokes; in other words, the distance between these lines must be equal to one-half of $C\ a$. The distance from b to $C\ C$ represents one-half the diameter of the crown, consequently the diameter of the crown is equal to one-half the diameter $f\ a$ of the mouth of the bell. From the point a as a center, and with a radius equal to 8 strokes, describe a short arc cutting the straight line b in the point 8; join the points a and 8 by a straight line; divide this line into eight equal parts; each part will then be equal to a stroke. Mark the points of division 1, 2, 3, etc., as shown, and through these points of division draw lines perpendicular to a 8. These lines are ordinates to the curve through center of the metal of the bell, and must be made equal to the length given in the following table; these lengths must, of course, be measured from the line a 8, with the scale of strokes.

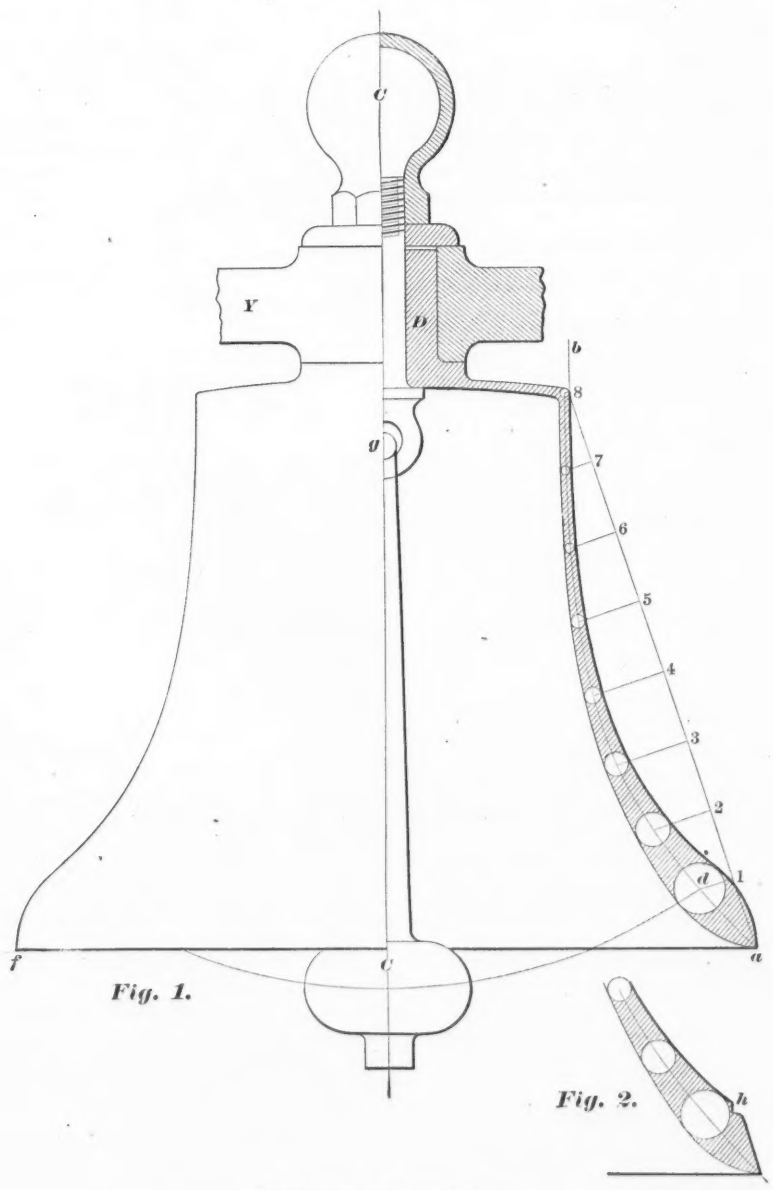


Fig. 1. *Fig. 2.*

CONSTRUCTION OF BELLS.

TABLE I.

Length of ordinate through point					1 = 0.41	stroke
"	"	"	"	"	2 = 0.86	"
"	"	"	"	"	3 = 1.02	"
"	"	"	"	"	4 = 1.00	"
"	"	"	"	"	5 = 0.87	"
"	"	"	"	"	6 = 0.66	"
"	"	"	"	"	7 = 0.39	"
"	"	"	"	"	8 = 0.09	"

Through the ends of these ordinates draw a curve, which will be the curve through the center of the metal. From the points in which the ordinates meet this curve, as centers, describe circles of the following diameter.

TABLE II.

Diameter of circle on ordinate					1 = 0.70	stroke.
"	"	"	"	"	2 = 0.45	"
"	"	"	"	"	3 = 0.33	"
"	"	"	"	"	4 = 0.26	"
"	"	"	"	"	5 = 0.22	"
"	"	"	"	"	6 = 0.20	"
"	"	"	"	"	7 = 0.19	"
"	"	"	"	"	8 = 0.18	"

Tangent to these circles draw the outer and inner curves, which will determine the thickness of the metal. At the bottom of the bell describe an arc from a center on the line $f\ a$, so that the arc will be tangent to the outer curve and pass through the point a. Another arc with about the same radius must be described passing through the point a, and tangent to the inner curve.

The crown of the bell is sometimes slightly curved as shown, sometimes it is made flat; in either case the lines which represent the outer and inner surfaces of the crown are drawn tangent to the circle on ordinate 8. After a bell has been drawn full size by the method here given, the drawing can be measured by an ordinary rule, and its dimensions in feet and inches obtained.

For the determining the diameter and length of the shank D, good judgment is required. For an 18 inch bell the shank is generally from $2\frac{1}{8}$ to $2\frac{3}{8}$ inches in diameter, and about $2\frac{1}{2}$ to $2\frac{3}{4}$ inches long. The bolt for fastening the bell to the yoke Y is from $\frac{7}{8}$ to 1 inch in diameter. The length of the clapper should be such that an arc passing through the center d of the circle on ordinate 1, and described from the center g, shall pass through the center of the ball on the clapper. The weight of the clapper should be from $\frac{1}{40}$th to $\frac{1}{50}$th the weight of the bell; the heavier weight is to be used for the smaller bells.

The proportions here given answer well for an ordinary locomotive bell. Should it be desirable to use a greater or smaller thickness of metal, we make the ordinates through the points of division the same length as before; and the diameters of the circles on these ordinates are found by the following table.

TABLE III.

Diameter of circle on ordinate					1 =	1 stroke.
"	"	"	"	"	2 = 0.653	"
"	"	"	"	"	3 = 0.474	"
"	"	"	"	"	4 = 0.380	"
"	"	"	"	"	5 = 0.327	"
"	"	"	"	"	6 = 0.291	"
"	"	"	"	"	7 = 0.279	"
"	"	"	"	"	8 = 0.267	"

If now we wish to make the thickness of metal on ordinate 1 equal to, say, $1\frac{1}{4}$ inches, we describe a circle $1\frac{1}{4}$ inches diameter; the diameters of the circles on the other ordinates are found in the following manner. Multiply $1\frac{1}{4}$ inch by 0.653, which is the diameter given in Table III for circle on ordinate 2; for the circle on ordinate 3 we multiply $1\frac{1}{4}$ inch by 0.474, which is the diameter given in the table for ordinate 3, and so on in succession for all the other circles, and then proceed as before. In a similar way we find the diameters of the circles for any other thickness, either more or less than an inch on ordinate 1.

Increasing the thickness of the metal at the bottom of the bell will make the diameter of the crown a little larger than one-half the diameter of the mouth, but this difference will not affect the tone of the bell to any appreciable extent.

If it is desirable to have a fillet h near the bottom of the bell, it should be drawn tangent to the circle on ordinate 1, as shown in Fig. 2. A good mixture for the metal is four of copper to one of tin; to every hundred pounds of this mixture add one-half pound of zinc, and one-half pound of lead.

Machinists' Supplies and Iron.

NEW YORK, November 8, 1890.

Iron—American Pig—The demand continues very much the same as last week, the standard brands being steadily absorbed, and prices well maintained except for some brands for which a reputation is yet to be established. All kinds of finished iron are in good demand.

We quote No. 1 Foundry, standard Northern brands, $17 to $18; No. 2, $16 to $16.50; Southern brands No. 1 Foundry, $16 to $17; No. 2, $15.75 to $16.

Scotch Pig—The demand continues moderate, and there is no quotable change in values.

We quote Coltness, $24.50; Dalmellington, $22 to $22.50, and Eglinton, $20.50.

Lead—There has been a light demand, which, combined with an abundant supply of both foreign and domestic, has caused a decline, values varying at present at about 5.10c. to 5.25c., according to brand.

Spelter—Sales have been small, and the market has ruled quiet.

We quote ordinary brands of Western at 6¼c. to 6¼c.; choice, 6⅜c. to 6¼c.; refined, 7¾c. to 8c.; Silesian, 7¾c. to 7½c.

Tin—Prices have declined here somewhat in sympathy with lower London quotations, values varying from 21c. to 21⅜c.

Antimony—Prices of Regulus have declined, and there is a moderate jobbing demand for Hallett's at 17¾c.; Cookson's 19¾c.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue

Engineer and salesman wants position. Steam pumping machinery specialty. Box 102, AM. MACH.

Wanted—Situation as foreman boiler maker; 25 years' experience; strictly temperate; good references. Address B. M., 743 Porter st., Detroit, Mich.

Wanted—Position as foreman of shop making fine tools or light machinery. A1 reference. Address Box 103, AMERICAN MACHINIST.

Wanted—Men to erect turret lathes. Good pay and steady work to experienced men. Gisholt Machine Co., Madison, Wis.

Wanted—Five or six first-class vise hands and erecters, at once. Gisholt Machine Company, Madison, Wis.

Experienced mechanical draftsman, with shop experience and technical education, wants situation. Address Box 2, AMERICAN MACHINIST.

Wanted—Situation by sober, steady machinist, in shop where would have steady work year round; piece work pref'd. "Steady Work," AM. MACH.

Wanted—Draftsman and designer on machine tools and general work; to first-class man permanent position. Address Box 1, AMER. MACHINIST.

Machinists Wanted—First-class floor hands and fitters of large experience and of good habits can find steady employment and liberal wages. Address Morgan Engineering Company, Alliance, O.

Wanted—Position as general foreman of machine shop, blacksmiths, etc., etc., by a man 40 years of age, thoroughly posted in the handling of men and new machinery. Box 101, AMERICAN MACHINIST.

Wanted—Partner who would invest some capital in utilizing of an important invention (dynamo without commutator or moving contact). Address Box 3, AMERICAN MACHINIST.

Wanted—Lathe hands and first-class pattern makers; only first-class men need apply; W. N. Y. & P. R. R. trains stop at the works mornings and evenings. Snow Steam Pump Works, Buffalo, N. Y.

Wanted—Bookkeeper for foundry and machine shop; young man with some experience in the business, and at moderate salary, preferred; state age, experience, references, and salary expected. P. O. Box 544, Cumberland, Md.

Wanted—In a clock factory, a machinist and tool maker, capable of originating and drafting small tools for special work, and of taking full charge of tool-room, with four men, and equipped with best modern tools; married man preferred. The E. Ingraham Co., Bristol, Conn.

Wanted—Foreman, thoroughly capable of obtaining first-class work from men and tools in shortest time possible, in fine brass work, with presses, monitor lathes, screw machines, etc.; must also be competent to design, and oversee making of tools for said machines. G. E., AMERICAN MACHINIST.

An experienced business man and engineer, experienced in steam and electrical matters, and an expert in general mechanics, is open for an engagement as manager of the New York business of some manufacturing concern; my age is forty-two, salary expected fair. Mr. Wood, AM. MACHINIST.

Superintendent—A member of the A. S. M. E. now in charge of an iron works employing 500 hands, desires to make a change before the end of the present year. Specialty, fine interchangeable machine and tool work, together with good designs and systematic shop management and accounts. Address Box 80, AMERICAN MACHINIST.

An American of 46, with good business training, mechanical knowledge and the handling of men, is open to an engagement with responsible concern in legitimate business. Building or selling machinery, steam engines or tools—or instruments of precision where mathematical calculations of the highest order are involved—practical—not a dude—will only consider an interest—no salary, and won't work over sixteen hours a day for anybody. Address Ebenezer Chips, AMERICAN MACHINIST.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Cheap 2d-hd lathes & planers. S M York, Clev'd, O.

Just out; aluminum-steel hack-saws, hard but not brittle. Crescent Mfg. Co., Cleveland, Ohio.

New catalogue of engineers' specialties free. Crescent Mfg. Co., Cleveland, Ohio.

Light and fine machinery to order; Foot Lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

Turned and Highly Polished Iron and Steel Shafting a specialty. Merwin McKaig, Cumberland, Md

Engineers wanted to send their addresses and receive free a 25 cent book, "Hints and Suggestions for Steam Users." Lord & Co., P. O. Box 1262, Phila., Pa.

Well located foundry and general repair shops for sale cheap, owing to death of proprietor. Address Helen Woodworth, Admin., Nunda, N. Y.

For Sale—Set of Patent Office Gazettes; full law binding; new and complete to 1888. Address Box 100, AMERICAN MACHINIST.

Wanted—Second-hand pulley turning mill, about 72"; Niles or similar style; send location, with full particulars. Georgia, AMERICAN MACHINIST.

Wanted to Buy—Second-hand power shear for boiler plate, about 30-inch throat. East End Boiler Works, Detroit, Mich.

Wanted—To buy second-hand lathes, planers and shapers of all sizes. Must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

For Sale—Bound volumes of the Patent Office Gazette for years 1883, 1884, 1885, 1886, 1887 and 1888. Price, $4 per year. Address J. C., care of AMERICAN MACHINIST.

Wanted—Engineers to write for Catalogue of all the latest and most valuable mechanical, scientific and electrical books which are given free with each barrel of the Pittsburgh Boiler Scale Resolvent. Pittsburgh Boiler Scale Resolvent Co., Pittsb'gh, Pa.

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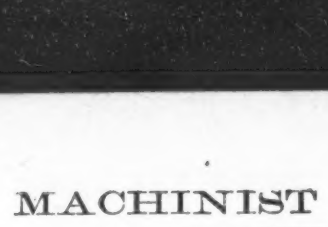

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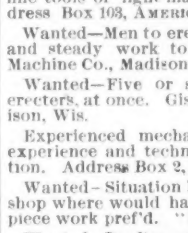

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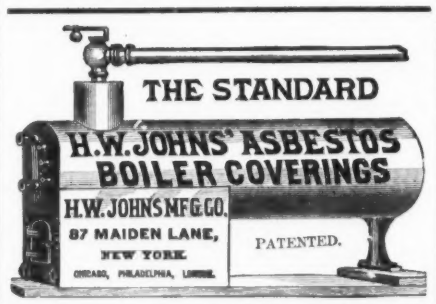

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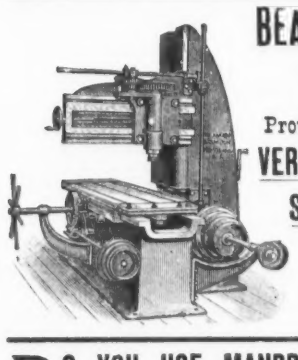

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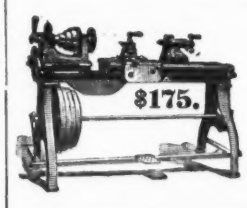

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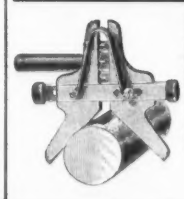

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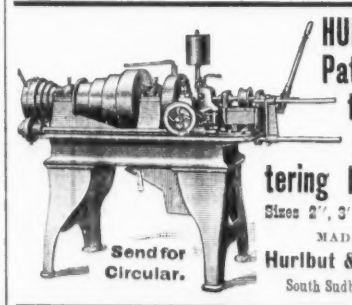

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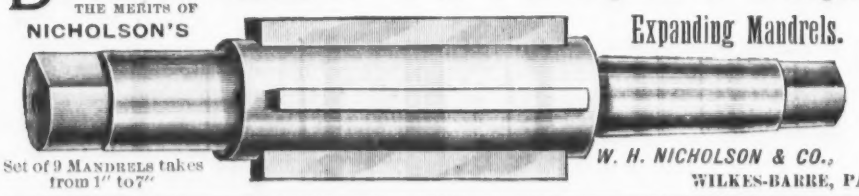

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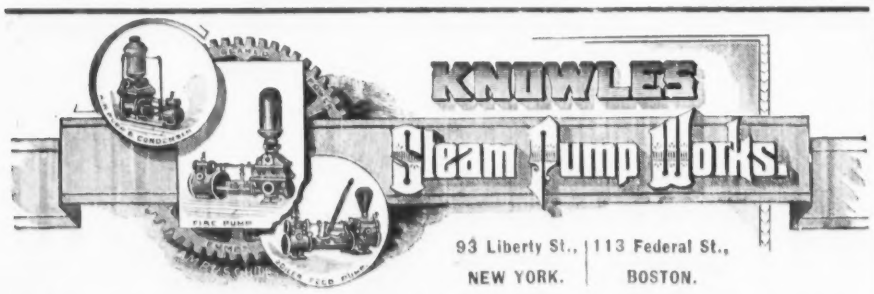

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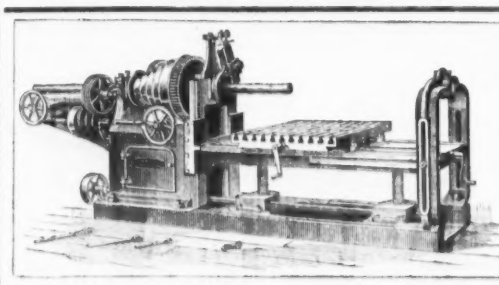

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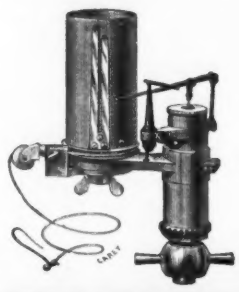

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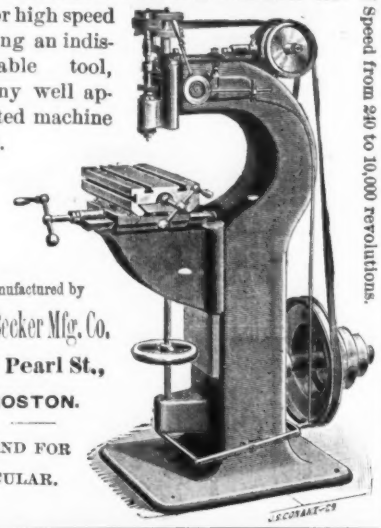

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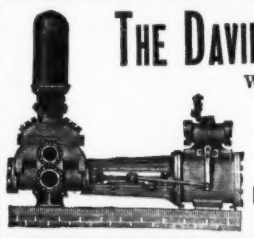

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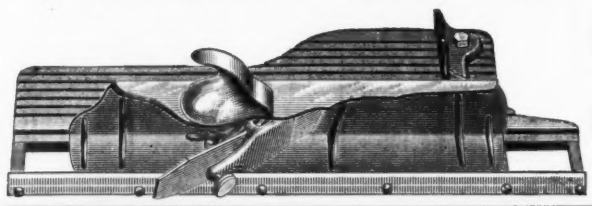

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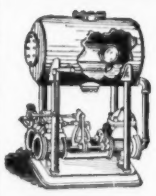

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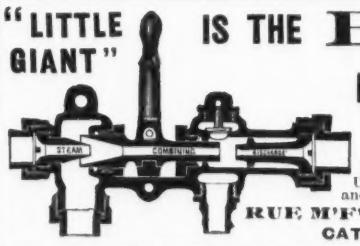

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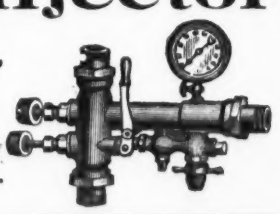

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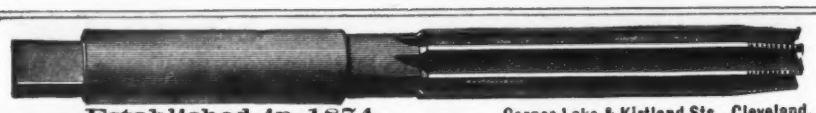

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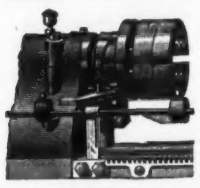

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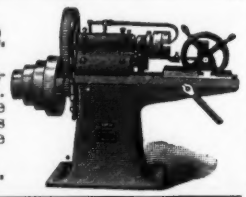

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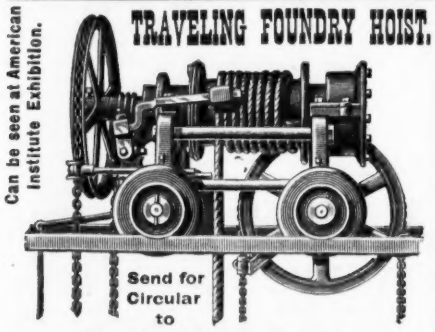

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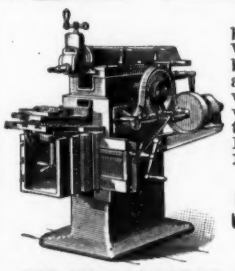

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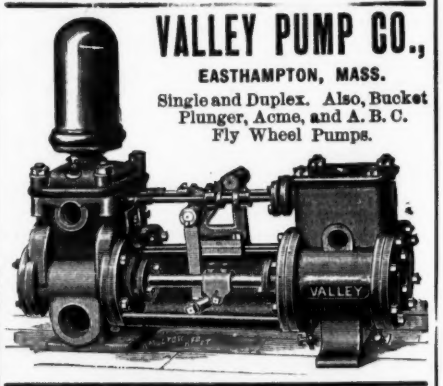

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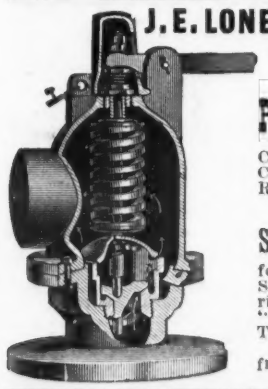

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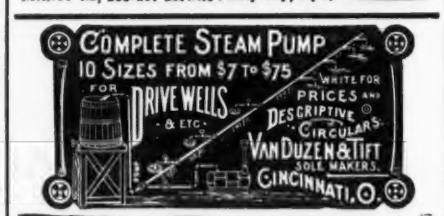

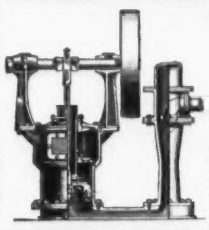

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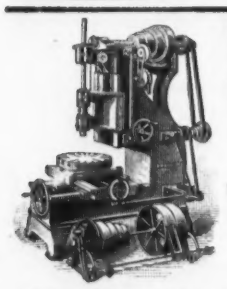

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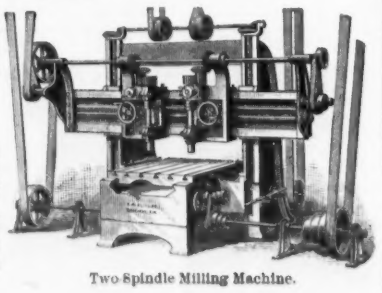

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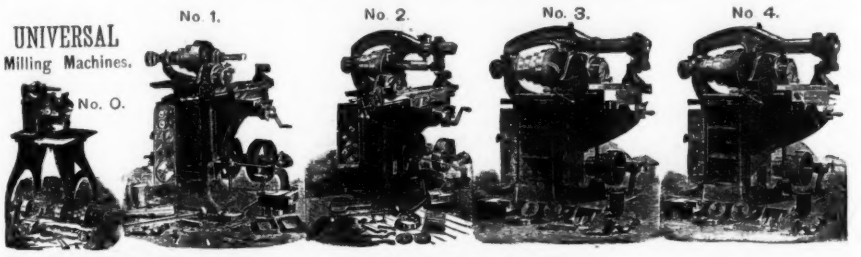

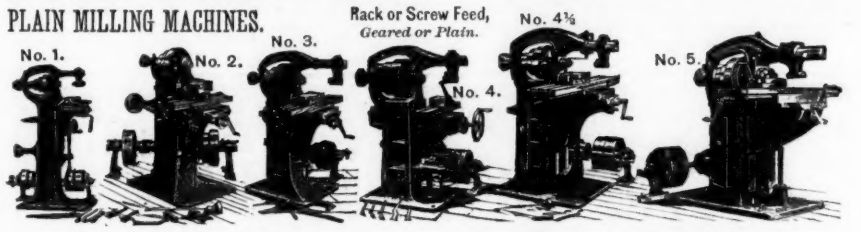

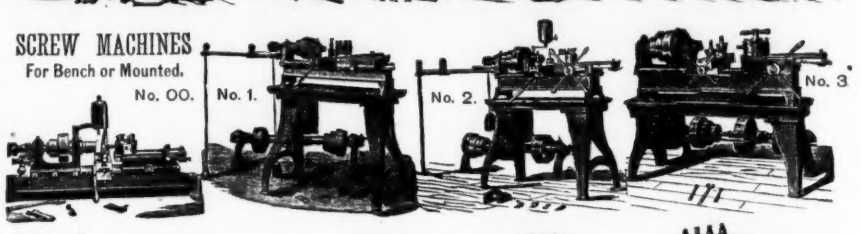

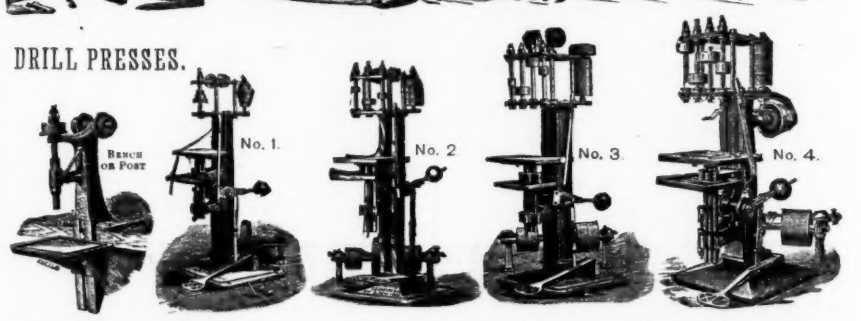

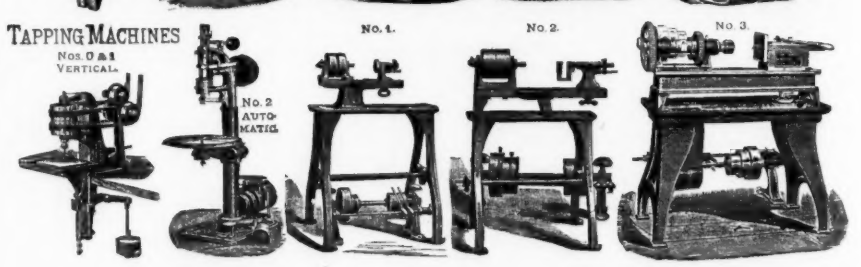

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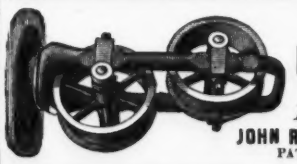

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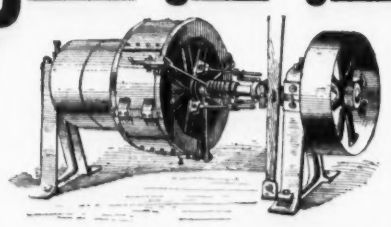

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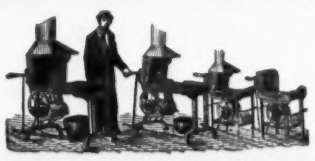

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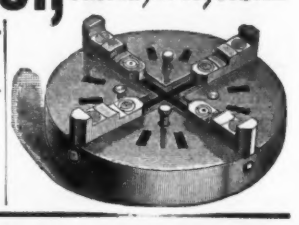

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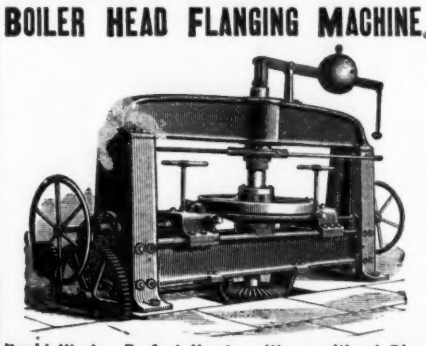

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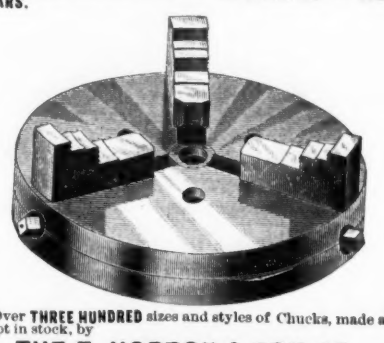

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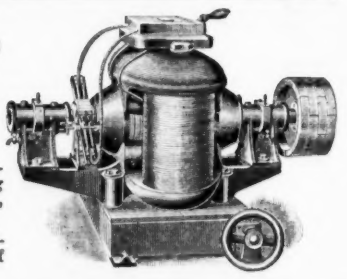

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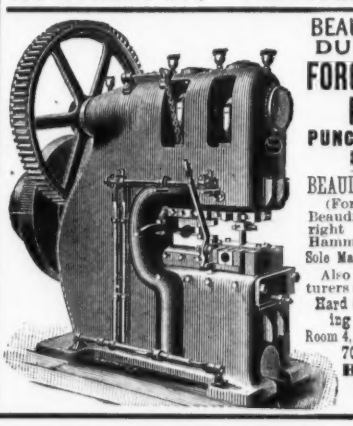

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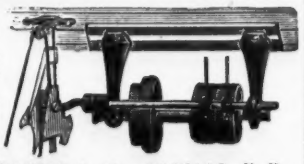

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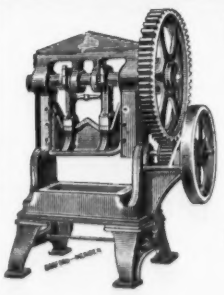

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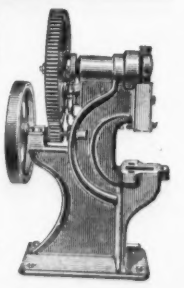

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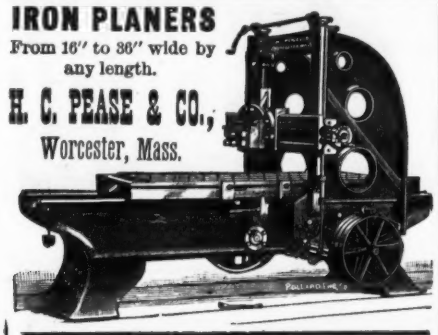

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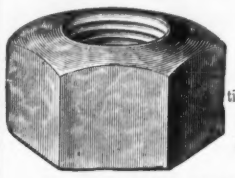

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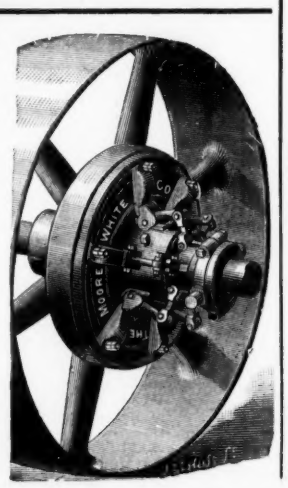

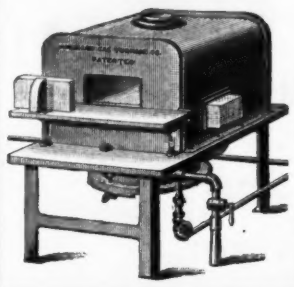

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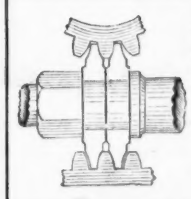

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Working by direct action of steam. Has no valves or other working parts, and cannot get out of repair, cannot freeze, and will pump ashes, waste, or anything that can enter the pipes. Invaluable as a bilge pump.
MADE IN LEAD OR BRASS FOR ACIDS.
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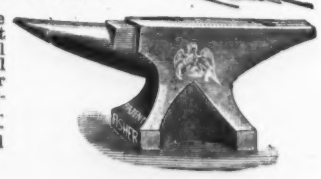
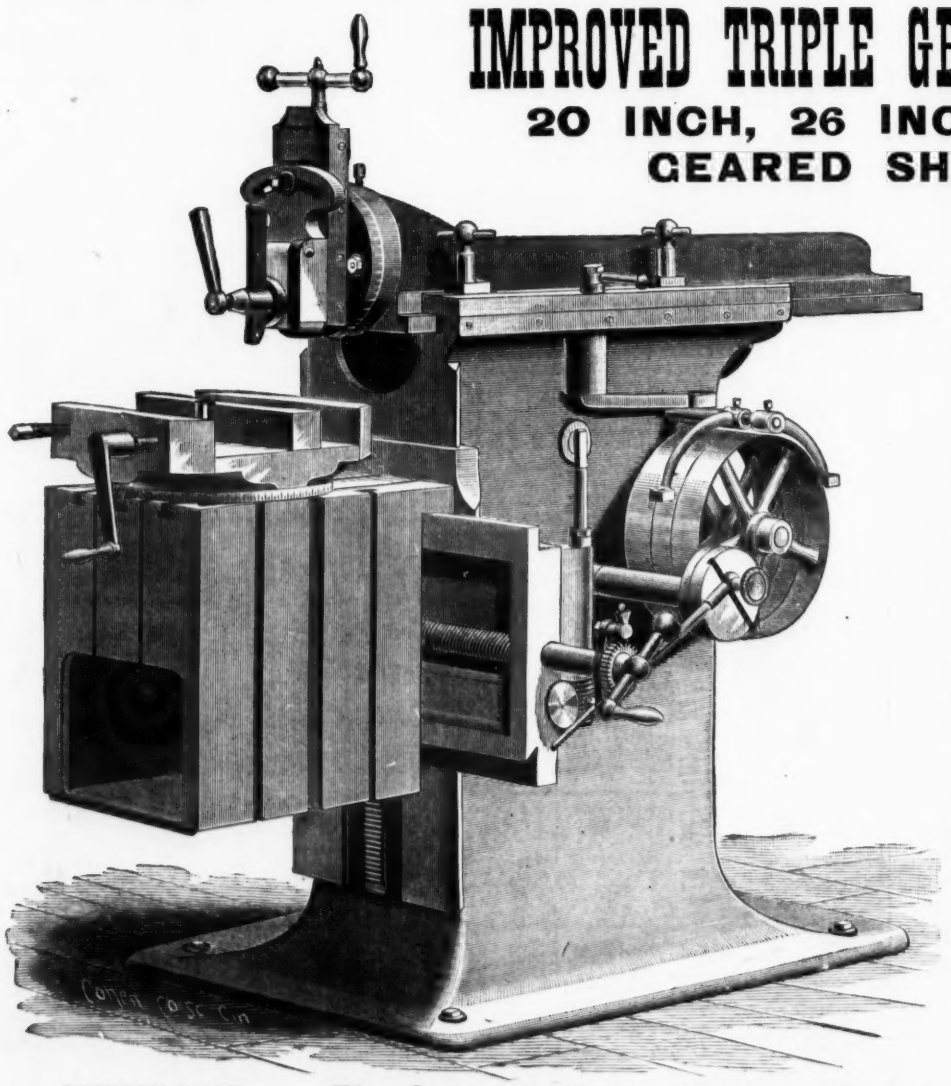
The Fisher Double Screw Leg Vise.—Warranted stronger grip than any other Vise. Always parallel and cannot be broken.
Send for Circulars.



The Eagle Anvil.—Best Cast Steel Face & Steel Horn. Better than any English anvil. Fully warranted and lower price.

IMPROVED TRIPLE GEARED SHAPERS.
20 INCH, 26 INCH, 32 INCH GEARED SHAPERS.



☞ Stroke can be changed while machine is running.
☞ A shaft can be passed under the ram through the column and a key seat planed in same to any length.
☞ Each machine complete with indexed swivel vise.

We manufacture also 15 inch and 20 inch Crank Shapers.

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The Lodge & Davis Machine Tool Co.,
WORKS: CINCINNATI, OHIO.
WESTERN HOUSE,
68 & 70 S. CANAL STREET,
CHICAGO, ILLS.
SOLE AGENTS FOR GREAT BRITAIN,
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Manufacturers of Morse Patent Straight-Lip Increase Twist Drills.

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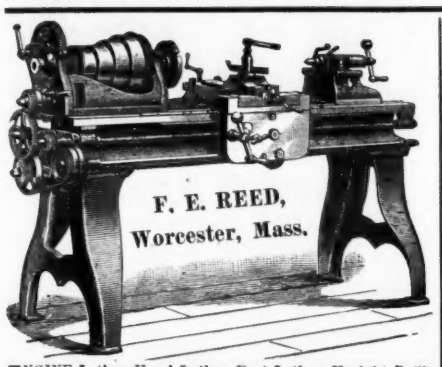
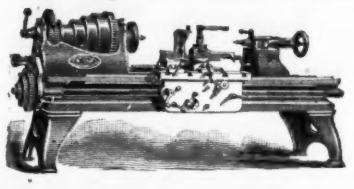
DRILL GRINDING MACHINES, MILLING CUTTERS AND SPECIAL TOOLS TO ORDER.



ENGINE Lathes, Hand Lathes, Foot Lathes, Upright Drills and Milling Machines. Agents, MANNING, MAXWELL & MOORE, 111 LIBERTY STREET, NEW YORK.



NEW HAVEN MANFG. CO.
NEW HAVEN, CONN.
IRON-WORKING MACHINERY,
Planers, Shapers, Drills, Slotters, Etc.

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MANUFACTURERS OF
Steam & Gas Fitters' Hand Tools.
SEND FOR CIRCULAR.

Pipe Cutting THREADING, AND Tapping Machines.

THE PATENT WHEEL PIPE CUTTER shown in the cut combines simplicity with strength and lightness. Easily adapted to various sizes of pipe. Rolling instead of sliding motion. No loose parts to become detached and mislaid. All wearing surfaces are of tool steel hardened. Less friction of parts than any other pipe-cutter made.

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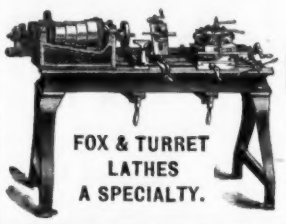

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14, 15, 16, 18, 20, 24 and 28 INCH SWING.
ANY LENGTH OF BED DESIRED.
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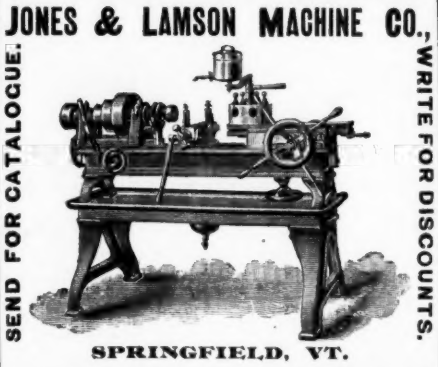

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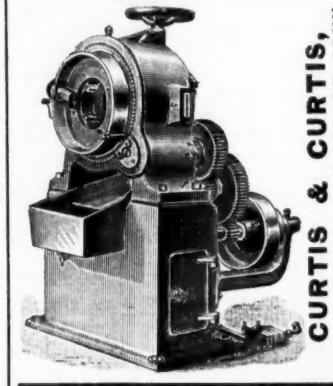
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66 CARDEN ST., BRIDGEPORT, CONN.
Pipe Cutting and Threading Machinery,
FOR HAND OR POWER.
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MALLEABLE IRON PIPE VISES

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IMPROVED PATENT IRON PLANERS A SPECIALTY.
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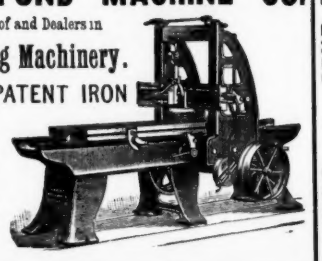

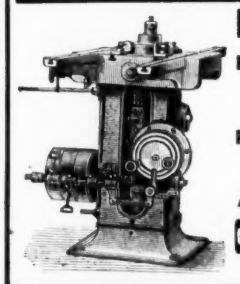

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PORTABLE AND STATIONARY.
RACK-CUTTING AND KEY-MAKING ATTACHMENTS.
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SEND FOR FALL LIST OF
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RACK CUTTER. Semi-Automatic.
GEAR or PINION CUTTER. Automatic.
PINION CUTTER. Semi-Automatic.
MARKING MACHINE. Improved Design.

NOTICE.
Our line of **Sensitive Drills** will hereafter swing 13 instead of 10 in. as formerly. All spindles provided with **steel racks**. The 2, 3 and 4 spindle drills mounted on new design columns. Tables adjustable.
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POWELL IRON PLANERS,
For Immediate Delivery.
One Planer 30 in.x30 in.x10 ft.
One " 36 in.x36 in.x12 ft.—2 heads.
One " 48 in.x48 in.x14 ft.—2 heads.
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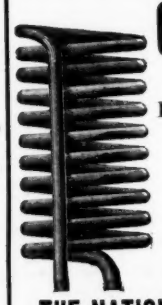
—OF—
IRON, BRASS and COPPER
PIPE.
ALL STYLES.



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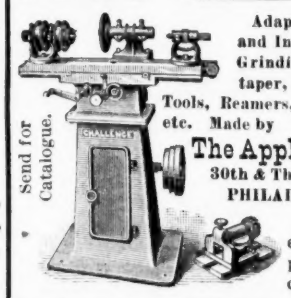

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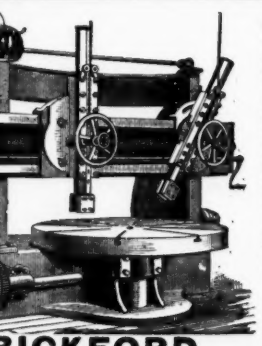

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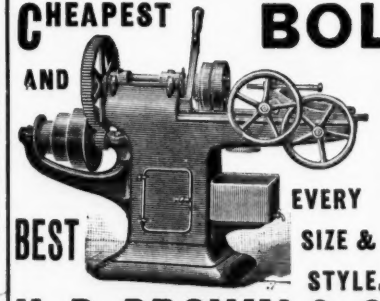

EVERY SIZE & STYLE.
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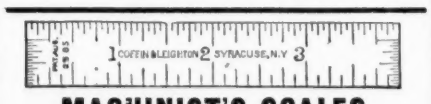

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PATENT END GRADUATION.
We Invite Comparison for Accuracy with all others.
EVERY SCALE GUARANTEED. SEND FOR LIST.
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Note the following features on our **New Universal Milling Machine.** Feed reversed without reversing motion of spindle. Table turned end for end; automatic feed in any position. Fast and slow elevation to the knee. Change gears as simple as on an engine lathe. Side center, tail stock and all the other desirable features of a modern Universal Milling Machine. A newly designed and very efficient double friction countershaft is furnished with every machine.

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Lathes from 10 in. to 20 in. swing. Largest Variety of Drills manufactured in the world.
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ESPECIALLY ADAPTED TO POINTING WIRE RODS AND WIRE FOR DRAWING.
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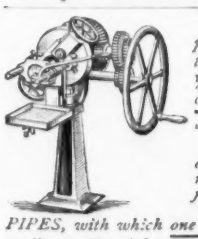

No. 1.—Powerful, inexpensive, simple in construction. Cuts and screws pipes ¼ to 2-inch. Easily carried about.

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No. 3 " " " 2½ to 6 in.
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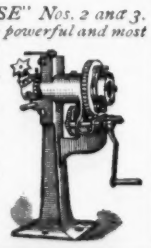

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We also build Power Machines.

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Maker of all kinds of
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Special facilities for Accurate Work.
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BARNES' NEW SENSITIVE DRILL
HAS THESE GREAT ADVANTAGES:
The speed can be instantly changed from 0 to 1600 without stopping or shifting belts. Power applied can be graduated to drive with equal safety, the smallest or largest drills within its range, a wonderful economy in time and great saving in drill breakage. Send for catalogue.
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SEND STAMP FOR FULL LIST.

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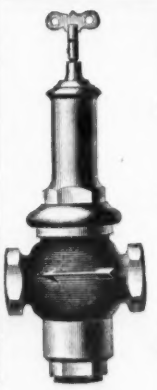
I feel so highly pleased with your Velocipede Foot Power with seat, that I wish to add my testimony to its superiority. I did not expect to like it, but having used the Velocipede Power I would have nothing else. It so greatly lessens the fatigue of using foot power, in fact, it may be said to be almost without fatigue and is a steadier motion. I only wish I had known of it sooner. SEND FOR CATALOGUE. W. F. & J. BARNES CO., 1995 Ruby St., Rockford, Ill.



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This Reducing Valve is the
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Used by Forty Railroads, and all the Largest Mills, Factories and Steam Plants.
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RELIABLE INSIDE CALIPERS
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5 inches, price per pair $1.25
Ideal Surface Gauges, Depth Gauges, Ideal and Leader Spring Dividers and Calipers, and Fine Machinists' Tools.
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Improved TURNTABLES for LOCOMOTIVES, CARS and PIVOT BRIDGES.
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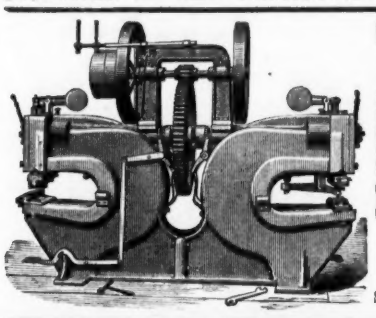

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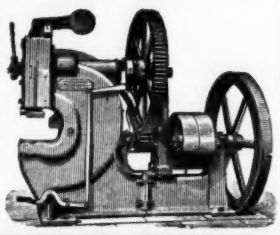

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In efficiency equal to the Standard Planers of the very best makes.
Capacity and adaptability unequaled by any metal planing tool.
Standard sizes 30 in. to 72 in. by any length.
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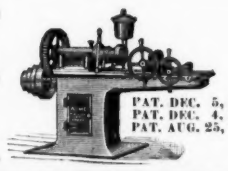

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Steel Pressure Blowers, Fan Blowers, Exhaust Fans, Lever & Crank Blowers, Portable Forges, Tire Benders & Shrinkers, Blacksmith Drills.
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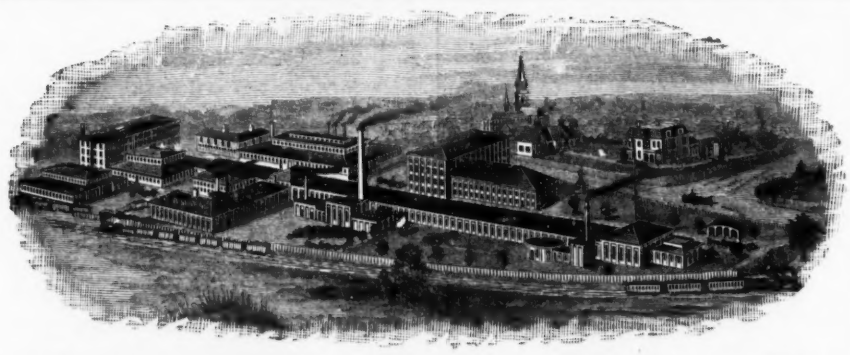

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Incorporated June, 1856; Established by
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These works have been fully equipped, at great cost, with heavy special tools, of his invention, for the manufacture of this perfected engine, which is a guarantee of superiority in workmanship, and interchangeability of parts never before attempted in the line of steam machinery.

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Especially adapted for compound and triple expansion engines requiring superheated steam and at very high pressure.

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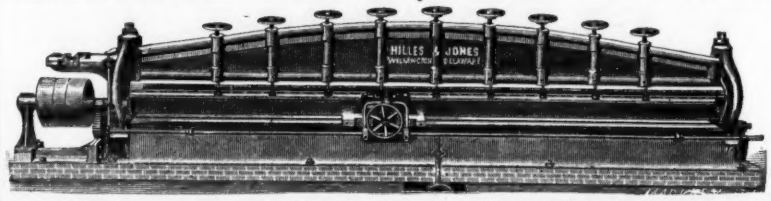

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Eight Sizes.
8'x20' length of cut.

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ALL OIL BELOW BURNERS! NO SMOKE, DIRT OR ASHES!
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SEPT. 29, 1885
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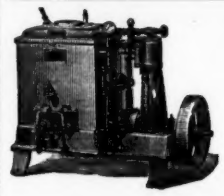
☞ We will replace in Stock or Mutual Companies any Insurance canceled on account of using this System, when installed according to our plans.



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— SAFE, EFFICIENT, DESIRABLE. —
The Best Power for Farmers, Printers, Carpenters and Manufacturers.
Automatic in both fuel and water supply, requiring but little attention after once started.
1, 2, 4, 6 and 8 H. P. Single.
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BUILDERS OF THE
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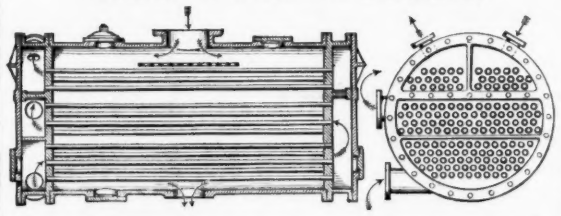

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FROM 1-4 TO 15,000 LBS. WEIGHT.
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Stronger and more durable than iron forgings in any position or for any service whatever.
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STEEL CASTINGS of every description.
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BARNARD'S SEPARATOR
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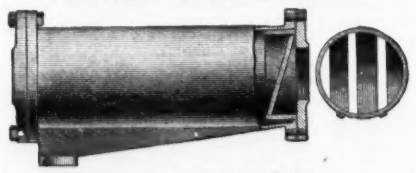

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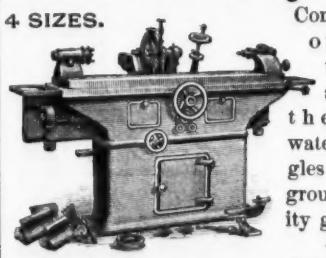

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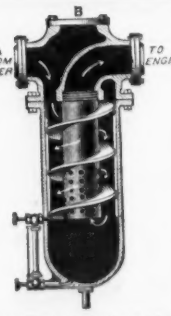

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Place Separator as close to engine as possible, the steam taking a spiral course between the threads causes the water to be thrown by centrifugal force against the outer walls, while the dry steam goes through the small holes to center of pipe. Steam can enter at A or B, as convenience may require; also used in conveying steam long distances, for Steam Hammers, Dry Houses, Water Gas Generators, and for all purposes where Dry Steam is necessary.
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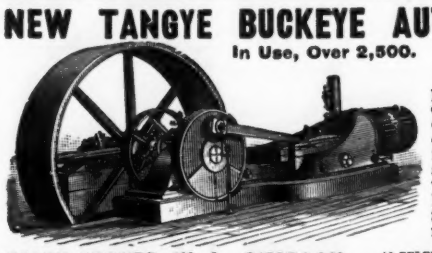

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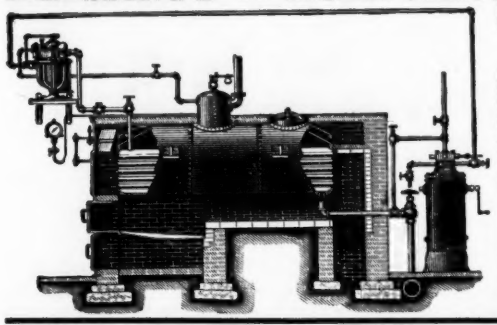

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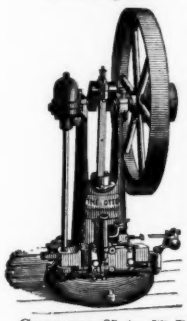

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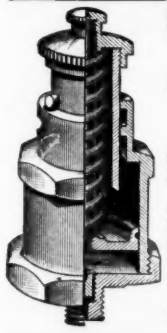

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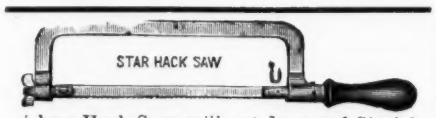

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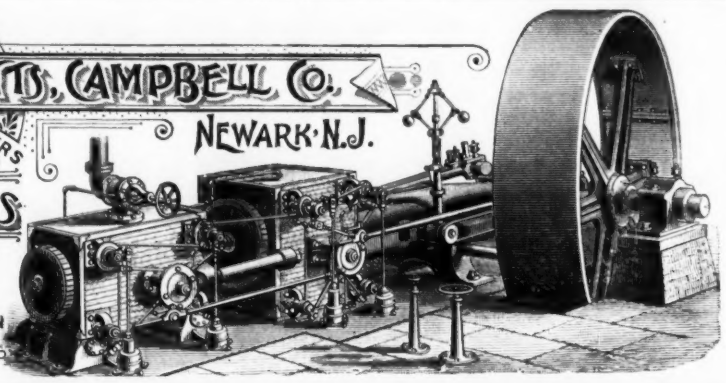

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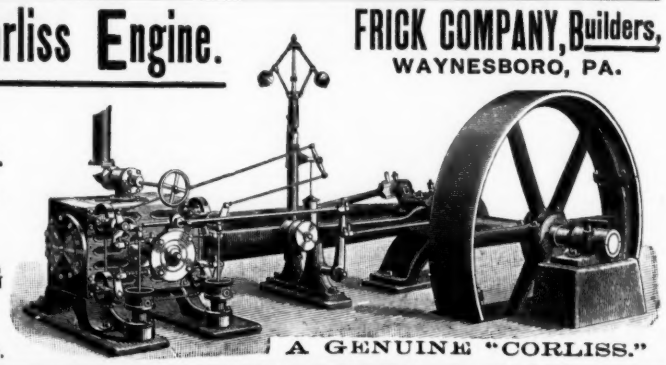

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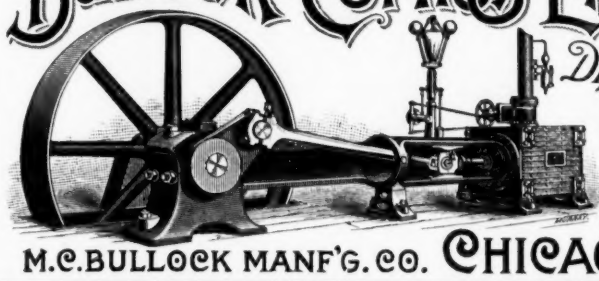

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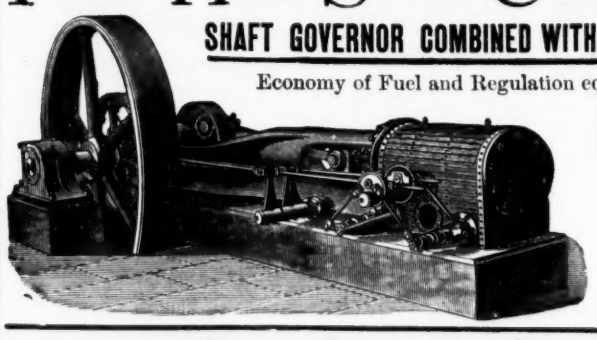

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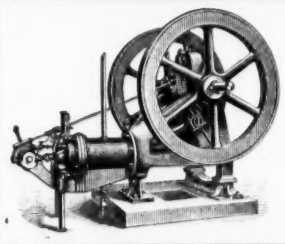

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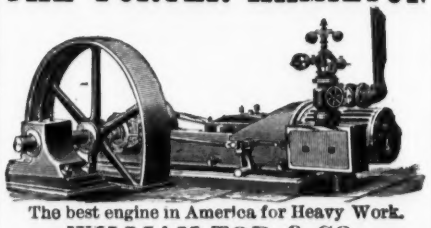

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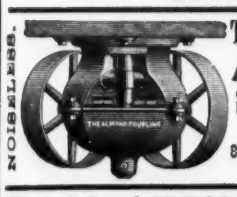

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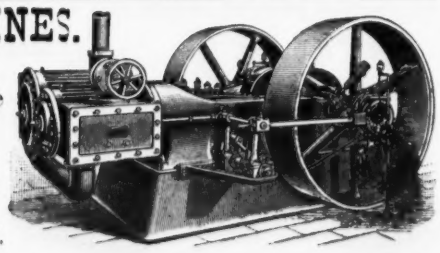

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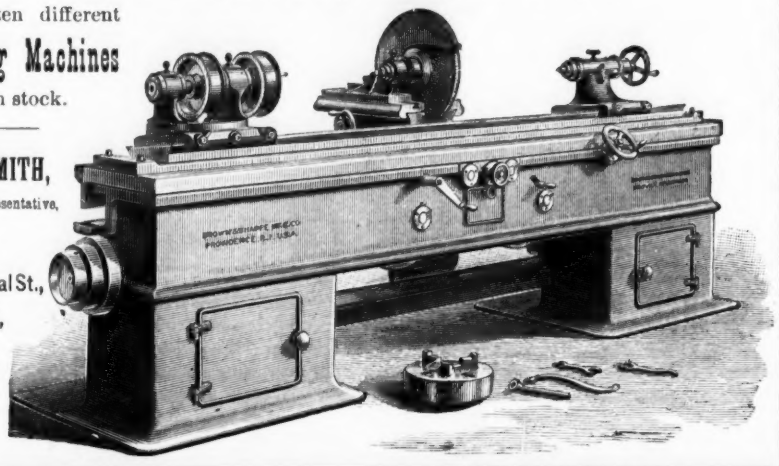

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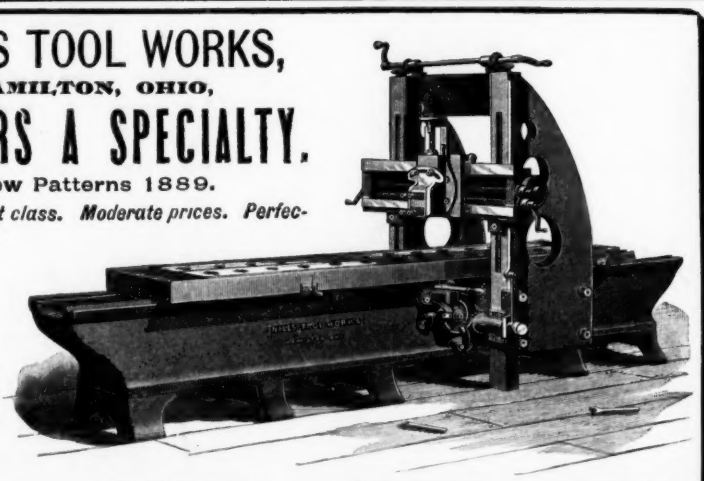

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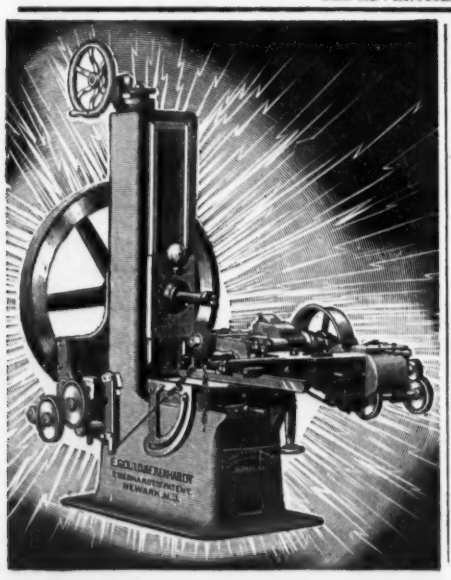

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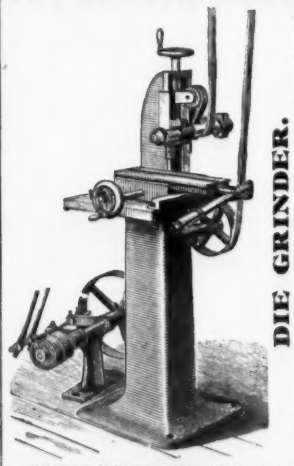

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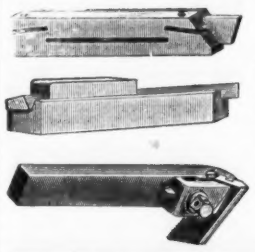

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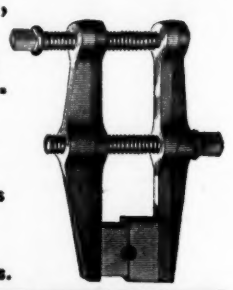

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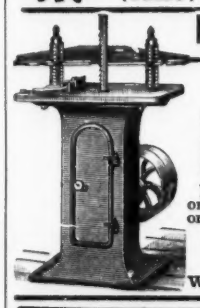

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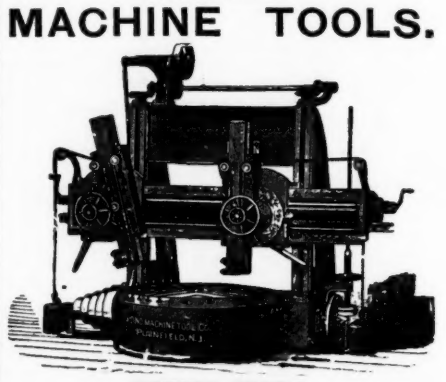

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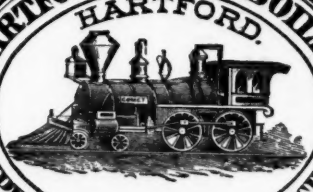

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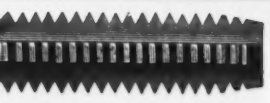

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